POWER

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A Merry Christmas

THE Christmas Spirit is abroad, and in that spirit I wish you, one and all to whom these presents may come, a Merry Christmas and a Prosperous and Happy New Year.

What is there in the Christmas Spirit that characterizes this festival among all the festivals of the year as "Merry"?

We have our patriotic festivals for the cultivation of Nationalism; we have our religious festivals; we have their anniversaries to keep alive the memory of the outstanding characters in our history; we have a day of fasting in the seedtime and of Thanksgiving in the harvest; we celebrate the completion of a year with mingled satisfaction and regret and start upon another with good resolutions and mutual wishes for a happy venture.

But about Christmas there is something different and characteristic, something typified by the merry, beaming face of Old Saint Nicholas himself.

He is happy because he is full of the spirit of giving. He is merry because he is making other people happy. You cannot imagine Old Santa Claus with any suggestion of self-interest, communing with himself as to how best to bestow his gifts in order that he may realize the greatest advantage or even the greatest gratification.

If the bag got low and he had to discriminate in the direction and extent of his giving, the consideration which would determine the bestowal would be "where will each do the most good?"

In the Christmas picture there is no suggestion of sacrifice. It is all happiness and merriment.

The joy of giving works at other times than at Christmas. You have seen it: in your plants, in your associations. There is the open-hearted, open-handed kindly fellow, always ready to do a good turn or lend a helping hand; and there are the Old Scrooges who never tell a thing that they know for fear of giving the other fellow an advantage, and who go on the principle that there is as much in getting rid of a job as there is in doing it.

How would a power plant crew, an engineers' association or a world composed of Old Scrooges compare with one composed of fellows filled with the joy of giving?

Not indiscriminate useless giving, but the timely lift when one is stuck on the center, the kindly word when things are going wrong, the hint and help that will make men realize their own possibilities; the giving of opportunity to work them out, and aid and direction in the endeavor. And above all and all the time the genial jolly outlook which sees the best in men and says "Come let us make merry together."

Hackensack Water Company's High-Head Pumping Engines

PUMPS, designed to operate against the unusually high head of 293 lb. per sq.in., maintain high efficiency over a wide range of operating conditions. Translated to power-plant standards, the duty obtained is equivalent to production of a kilowatt-hour at the switchboard on 16,600 B.t.u.

TWO identical vertical, triple-expansion pumping engines operating against the unusually high discharge pressure of 293 lb. per sq.in., have been installed recently at the New Milford, N. J., pumping station of the Hackensack Water Co., by the Allis-Chalmers Manufacturing Co. Discharge pressures as high as this are frequently met with in horizontal practice, but it is the builder's experience that fully 90 per cent of vertical triple-expansion engines operate against heads below 150 lb. per square inch.

The Hackensack Water Co. supplies water for a large number of communities lying along the Hudson and Hackensack Rivers for a distance of nearly 30 miles north of Hoboken, N. J. There are four principal pumping stations, the largest being at New Milford and New Durham, N. J. They are equipped with nine vertical, triple-expansion engines and a number of horizontal Corliss-engine-driven low-lift centrifugal pumps supplying water for a rapid sand filter plant. Owing to construction work incident to enlarging capacity, the latest engines will be required to operate for some length of time at widely varying discharge pressures. For some months the pressure will be 216 lb. per sq.in. and then will be raised to 250 lb., at which point the engines will operate for some years. On the completion of a projected reservoir and further extension of the pipe lines, the head will be raised to 293 lb. per square inch.

These engines have proved perfectly satisfactory in meeting the wide range of operating conditions as to economy and mechanical operation. In their design the

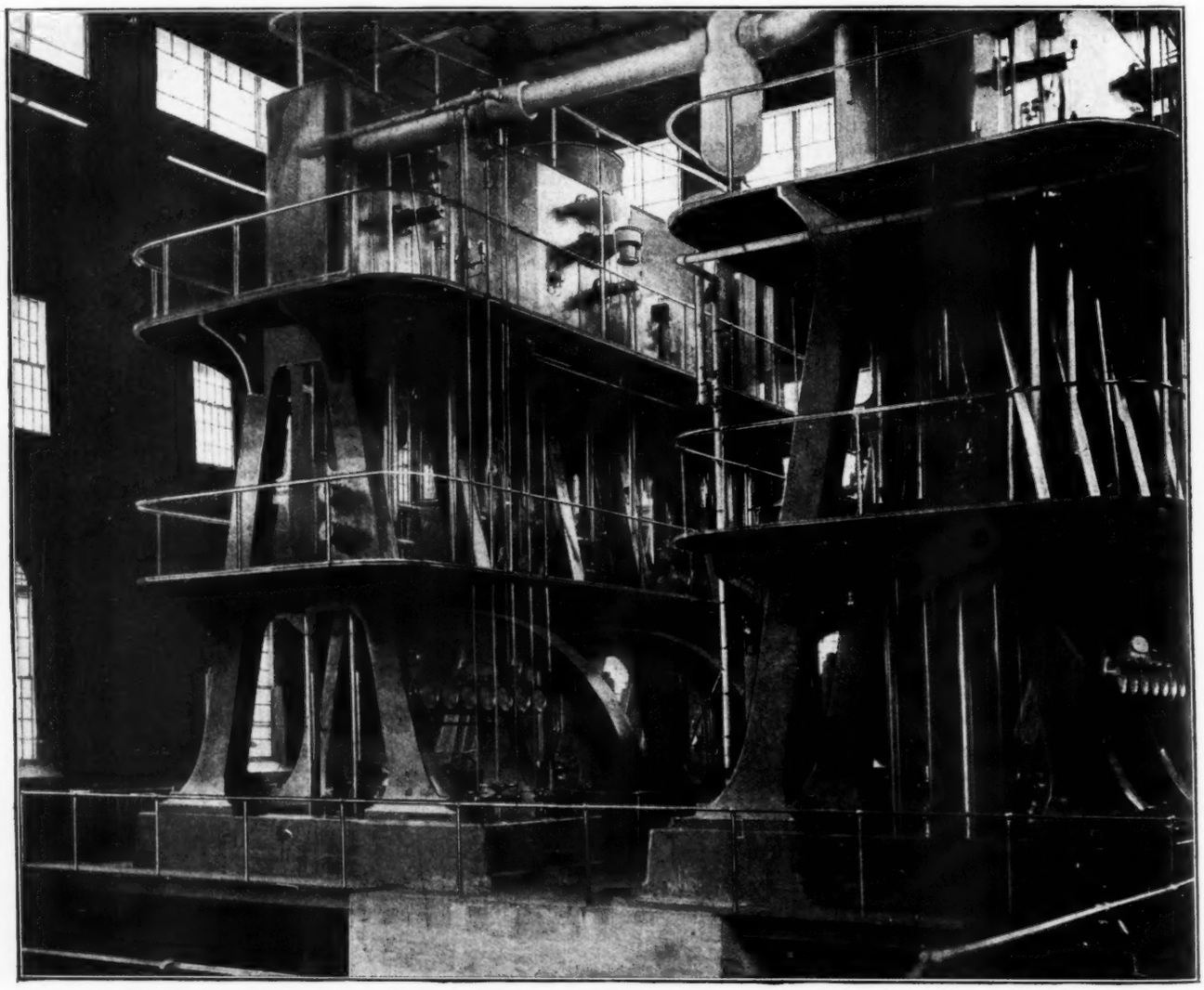

FIG. 1—THE 7,500,000-GAL. TRIPLE-EXPANSION PUMPING ENGINES OF HACKENSACK WATER CO.

so-called pier type of construction was used; that is, one side of the steam engine rests on a concrete pier, the other side being supported by the pump chambers.

The steam-engine cylinders are jacketed on the barrels. Their diameters are 36, 56 and 86 in. respectively, with a 60-in. stroke. They are supported by three pairs of massive box-section "A" frames resting on the main engine bedplates. The crosshead guides are cast integral with the "A" frames.

TABLE I—PRINCIPAL DIMENSIONS OF PUMPS

1. Number of units	2
2. Normal capacity in 24 hours, million gal.	7.5
3. Minimum total head	216 lb. or 500 ft.
4. Normal total head	249 lb. or 575 ft.
5. Maximum total head	293 lb. or 675 ft.
6. Steam pressure at throttle, lb. per sq.in.	175
7. Vacuum in exhaust pipe, in. mercury	27
8. High-pressure cylinder, in.	30x60
9. Intermediate cylinder, in.	56x60
10. Low-pressure cylinder, in.	86x60
11. Pump plungers, in.	20½
12. Flywheels, two each, diam., ft.	18
13. Weight each wheel, lb.	60,000
14. Total weight of steam end, lb.	85,000
15. Discharge chambers, inside diam, in.	51
16. Condenser, surface type, in suction line, sq.ft.	1,200
17. Air pump attached to h.p. plunger head, in.	26x60
18. Suction nozzle, diam., in.	30
19. Discharge nozzle, diam., in.	24
20. Total weight of unit, lb.	1,255,000
21. Guar. duty at 500 ft. head, ft.-lb. per 1,000 lb. steam	175,000,000
22. Guar. duty at 575 ft. head, ft.-lb. per 1,000 lb. steam	176,000,000
23. Guar. duty at 675 ft. head, ft.-lb. per 1,000 lb. steam	172,000,000

Corliss valve gear is used on the high-pressure and intermediate cylinders, while single-beat poppet valves serve the low-pressure cylinder. The high-pressure cutoff is controlled by an oil-pressure cylinder actuated through a relay valve connected to a high-speed centrifugal flyball regulator.

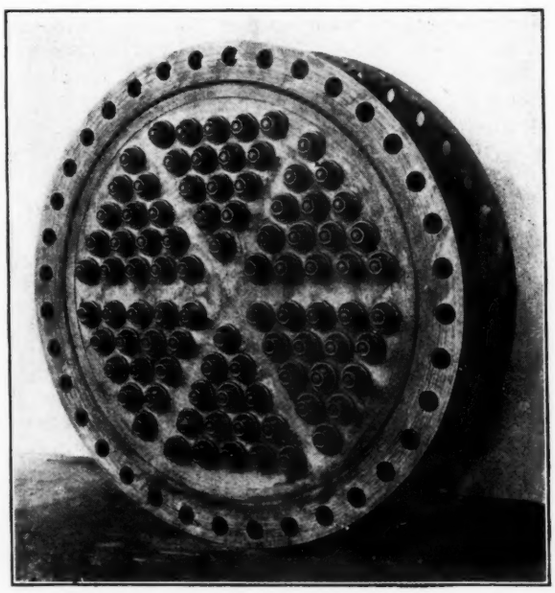

FIG. 2—CAGE PLATE SHOWING TYPE AND ARRANGEMENT OF VALVES

The water end is especially massive in construction. The valve decks and those chambers that are subjected to pulsating pressure are of cast steel; the rest of the chambers are of cast iron. The pump valves are arranged on large flat horizontal decks which, owing to small capacity, in this case make a more compact and economical arrangement than the usual system of removable cages. On account of the high pressures encountered, special valves were adopted, the valve deck of which is shown in Fig. 2.

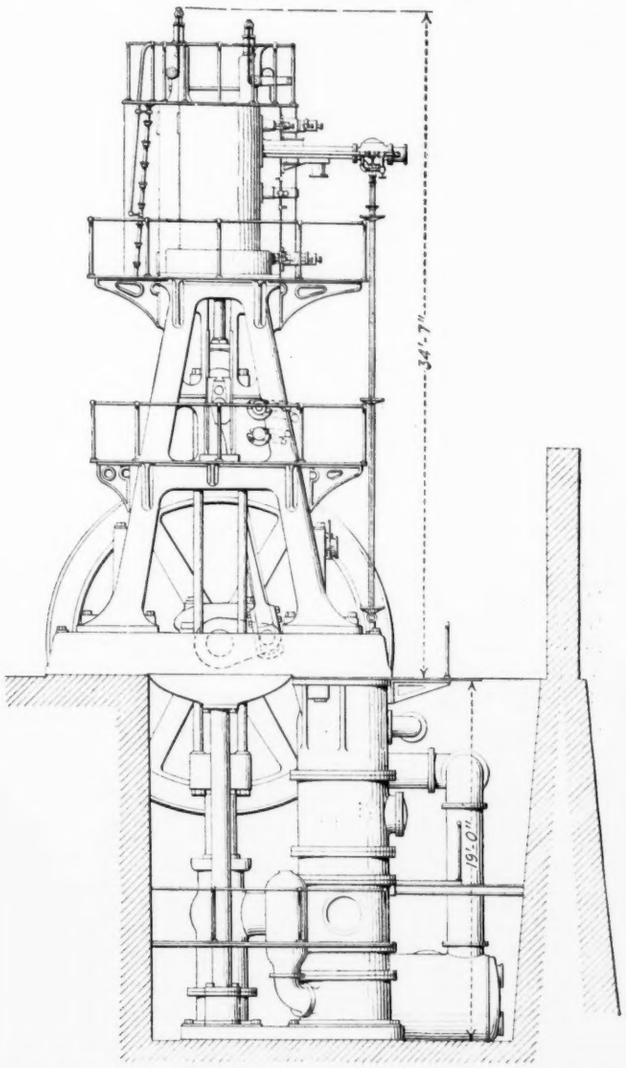

FIG. 3—SIDE ELEVATION OF PUMPING ENGINE SHOWING PIER TYPE OF CONSTRUCTION

The pump plungers, three in number, are single-acting. Each has a diameter of 20.5 in. and a stroke

TABLE II—SUMMARY OF OFFICIAL DUTY TESTS

	Engine No. 8			Engine No. 9		
Total head, as per contract, ft.	500	575	675	500	575	675
Duty guaranteed, millions of ft.-lb. per 1,000 lb. dry steam	175	176	172	175	176	172
Date of test	5-10-22	5-12-22	5-15-22	4-24-22	4-27-22	4-29-22
Duration, hours	5	10	5	5	10	5
Steam pressure at throttle, lb. gage	174.0	174.8	175.5	174.6	173.6	173.7
Vacuum in exhaust pipe, in. hg	28.64	28.24	28.03	29.05	28.50	28.52
Total dry steam used during test, lb.	37,507	86,442	51,074	37,996	86,282	51,056
Average revolutions per min.	20.6	20.52	20.56	20.56	20.59	20.62
Average rate of pumpage, gal. per 24 hr.	7,631,519	7,600,890	7,614,470	7,614,470	7,626,815	7,636,691
Average total head pumped against, lb. per sq.in.	216.58	251.27	290.89	219.80	251.00	293.08
Average delivered hp.	669.4	773.7	897.3	678.0	775.5	906.6
Average overall mechanical efficiency, per cent	95.2	96.6	96.9	96.4	97.4	97.2
Average indicated hp.	703	801	926	703	797	933
Dry steam per i.hp.-hr., lb.	10.67	10.79	11.03	10.81	10.83	10.94
Dry steam per delivered hp.-hr., lb.	11.20	11.19	11.40	11.20	11.12	11.28
Duty per 1,000 lb. dry steam, ft.lb. work	176,705,000	177,214,000	173,924,000	176,652,000	177,957,000	175,306,000
Duty per 1,000,000 B.t.u. supplied, ft.-lb. work	158,436,000	159,500,000	157,457,000	157,696,000	159,658,000	158,733,000
Thermal efficiency of unit, per cent	20.36	20.52	20.24	20.27	20.52	20.40

of 60 in. The principal dimensions of the pumps appear in Table I.

These engines were the subject of numerous carefully conducted tests, the results of which are summarized in Table II and the set of curves in Fig. 4. The curves show strikingly the flexibility of this type of engine and the degree to which it maintains its

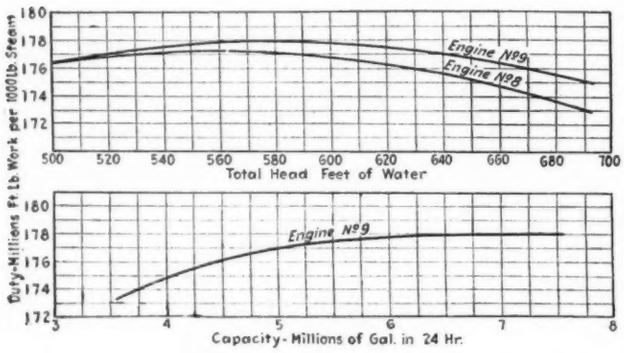

FIG. 4—CURVES SHOWING VARIATION OF DUTY WITH HEAD AND CAPACITY

efficiency over a wide range of operating conditions. No changes in valve setting were made to produce these results after the engine was once adjusted. The maximum change in duty over a range of nearly 50 lb. from the normal is only 2 per cent at full speed, while the duty at half speed was only 2 per cent less than the maximum, under the normal condition of 250 lb. discharge pressure. No other type of pumping machinery can approach this performance. The duty obtained in these tests is in line with the best obtainable with this type of unit.

In considering the economy of units of this type, it should be remembered that they are entirely self-contained and have no independent auxiliaries whatever. In this case attached boiler-feed pumps were pumping directly to the boilers through economizers, an attached sump pump was constantly delivering water from the basement to the sewer, and the vacuum pump was driven from the high-pressure plunger head. The unit is charged with the friction loss of the circulating water passing through the condenser, which is located in the main suction line. An attached air compressor furnished air for the poppet valves, the surplus at 80 lb. per sq.in. being used in processes around the filter plant.

In order to make comparison with other types of steam equipment more simple, the unit of economy may be translated into that of central-station practice, thus: The unit for the pumps is called duty and in this case means that the power delivered in the water at the discharge nozzle of the pump is equivalent to 159,658,000 ft.-lb. of useful work reckoned from the pressure at the suction nozzle for each 1,000,000 B.t.u. supplied at the engine throttle, reckoning from 32 deg. F. and crediting the engine with heat in the high-temperature jacket and drain water. A duty of 159,658,000 ft.-lb. per 1,000,000 B.t.u. is equivalent to a heat consumption of 12,400 B.t.u. per delivered horsepower-hour, including all auxiliaries, or to 16,600 B.t.u. per kilowatt-hour at the switchboard.

Electrical Instrument Applied to Measurement of Fluids

BY E. H. FREEMAN*

IN MEASURING the flow of steam or other fluids, the application of electricity has been in use a number of years and its advantages are well recognized. The one apparent objection to electrically operated flow meters has been the error due to fluctuations in the voltage of the lines from which they are operated. Where the voltage varies uniformly over a moderate range—for instance, from 108 to 112 volts—the electrical instruments can be set for a mean value, say 110 volts, and the average result over a period of time will be sufficiently accurate for practical purposes.

However, in many cases it is impossible to obtain an average voltage with sufficient accuracy, owing to poor voltage regulation or other conditions not under control. It is for this latter group primarily that the writer has developed an electrical integrating instrument that is practically free from voltage error. This instrument is as simple as the ordinary alternating-current watt-hour meter and equally dependable, if not less likely to get out of adjustment.

The instrument is not a watt-hour meter, neither is it an ampere-hour meter. Considered as an electrical instrument, it sums up, or integrates, the conductance—that is, the reciprocal of the resistance—of a circuit with respect to time, and therefore might be called an integrating "mho-meter." When used in connection with a device by which the electrical conductance increases (and the resistance decreases) as the rate of flow of a fluid increases, the instrument becomes a fluid flow integrator or totalizer.

Without using mathematical equations, the elementary principles of this instrument may be set forth and its chief characteristics explained by reference to the diagrammatic drawing, Fig. 1, and to other instruments whose principles are well known. In the diagram an aluminum disk D mounted on the shaft S rotates in the air gaps of two pairs of electromagnets having the windings C_1 and C_2, respectively. The coils C_1 are connected in series with each other and across the secondary of the transformer N. The coil C_2 is connected in series with the resistance R, the two being across the secondary of the transformer in parallel with the coils C_1.

Pipe P carries the steam or other fluid to be measured and the orifice O causes a pressure drop, or differential pressure, between the two sides of the orifice. The differential pressure raises the mercury in the U-tube B, the mercury thus short-circuting more or less of the resistance R. By construction, the resistance of the circuit through C_2 and R can be made to vary inversely (and the conductance directly) as the rate of flow of a fluid at constant density.

The coils C_1 contain a large number of turns and are

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highly inductive, for which reason the lag of the current behind the voltage approaches 90 deg. The coil C_2, however, has a smaller effective number of turns, and being in series with the resistance R, which is large in proportion to the inductive reactance of the coil, the inductive effect of C_2 is practically negligible and the current is nearly in phase with the voltage. Since the currents in these two coils have a large and practically constant phase difference, the corresponding magnetic fluxes of F_1 and F_2 react on currents induced in the disk to produce a torque thereon in a manner similar to that of the ordinary induction-type watt-hour meter. This accelerating, or driving, torque varies as the product of these two fluxes, a relation well known and used in all induction-type meters. A change in frequency may tend to modify the torque, but this tendency has been rendered negligible for the usual frequency fluctuations by incorporating in the meter, as manufactured, special features not here shown without in any way departing from the fundamental principles under discussion.

As the disk rotates under the action of the driving torque, it cuts across the fluxes of F_1 and F_2 and by this movement has currents induced in it which oppose the motion and thereby give a retarding, or dragging torque. This action is similar to that in a watt-hour meter where one or more permanent magnets, sometimes called drag or damping magnets, provide the retarding torque. By construction the flux of F_1 is made so large in comparison with the flux of F_2, that the retardation is due almost entirely to the flux F_1. Thus the electromagnet with the windings C_1 functions in a manner similar to the permanent magnets of a watt-hour meter in giving the retarding torque and at the same time does its part in producing the accelerating torque. This retarding action varies directly as the speed of the disk and as the square of the flux and therefore as their product, a relation applying to the permanent magnets of watt-hour meters or to any magnet whose flux is cut by a conductor forming a closed circuit.

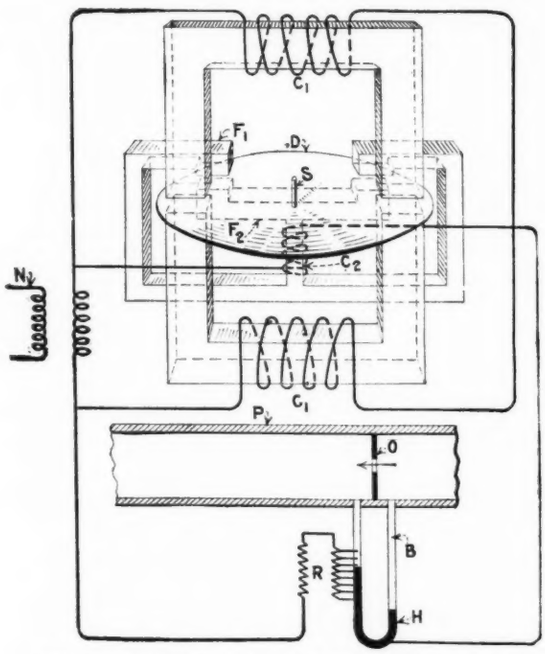

FIG. 1. WIRING DIAGRAM SHOWING ACTION OF INTEGRATOR

Referring again to the relation that the driving torque varies as the product of the two fluxes of F_1 and F_2, it will be seen that, for any fixed value of R, F_1 and F_2 will each vary practically directly with the voltage from the transformer N. Hence the accelerating torque varies practically directly as the square of this voltage. It also follows that the retarding torque, since it varies as the square of the flux F_1, likewise varies as the square of the voltage. Neglecting friction on the disk, which is very slight, the speed will take such a value that the accelerating and the retarding torques will be equal and opposite; and since each varies practically in the same way with the voltage, ordinary fluctuations of voltage will have substantially no effect on the speed of the disk. This is a condition desired, for the reason that the velocity of the fluid in the pipe P has no connection with changes in voltage of the transformer N.

FIG. 2. FLOW INTEGRATOR WITH COVER REMOVED

By construction, as previously mentioned, the resistance R is made to vary inversely, and the conductance of the circuit directly, as the rate of flow of the fluid to be measured. But the current in the coil C_2, and hence the flux of F_2, varies directly as the conductance and therefore directly as the rate of flow of the fluid. The driving torque increases as the flux of F_2 increases, hence the speed of the disk will be proportional to the velocity of the liquid through the orifice. Any changes in F_2 caused by fluctuations in voltage will be accompanied by corresponding changes in F_1 so that the accelerating and the retarding torques will be equally affected and the speed of the disk will vary only with the rate of flow of the fluid.

Obviously, if the speed is proportional to the rate of flow, the total number of revolutions of the disk is a measure of the total quantity of the fluid passing through the orifice. These revolutions are counted by the usual gear trains with dials, so that the dial indications give a direct summation or integration of the total flow in any desired units.

This integrating instrument has been adopted by the Republic Flow Meters Co., of Chicago, and is now standard equipment, replacing the type formerly used.

The pull-out torque of an induction motor is the maximum torque that it will develop at normal volts after being allowed to run up to normal speed; that is, the maximum torque the motor will develop when loaded to a point where it stalls. The pull-out torque is from 2 to 3.5 times the full-load torque..

Measuring Devices for Refrigerating Plants*

By JOHN E. STARR

A REFRIGERATING plant cannot be operated at its best efficiency unless the proper measuring devices are installed. These consist of thermometers to indicate the temperatures, gages to measure the pressures carried, meters to gage the brine circulation and an indicator by which the compressor and engine operation may be checked.

INSTRUMENTS that will measure the several steps in the refrigerating cycle are necessary to use in order that we may properly control these steps and have knowledge as we proceed that we are proceeding properly. It is of the utmost importance that we know the weight or the number of pounds of liquid refrigerant circulated per unit of time. For in case of any liquid whose physical properties are well known (such as ammonia), if we know the temperature at which it is fed to the boiler and the quantity boiled by our refrigerating temperatures in a unit of time, we know the amount of heat taken up. For this reason the instrument showing the temperature of the liquid just before passing the expansion valve—that is, the liquid thermometer—is the most illuminating and important one in the plant. Coupled with this, a second instrument for showing the pressure at which the liquid is boiled is, of course, necessary, also an instrument showing the number of pounds circulated per unit of time.

Having accurate instruments to show these three conditions, the actual plant capacity is quickly, easily and accurately determined. Where brine is used as a heat carrier, a check can be made, but it is hardly necessary, as the aforementioned method of arriving at capacity has proved satisfactory and is imperative in direct expansion work. It follows the very familiar routine of calculation for steam-boiler efficiency and capacity, for if we know the temperature of our feed water, the pressure of our boiler and the pounds fed to it, we are in a position to calculate exactly how much heat is put into it.

Thermometers on the Feed Line

With an oil-filled thermometer well on the feed line about 1½ or 2 feet before the expansion valve, a reliable glass thermometer can be made to give an accurate record. A recording thermometer can also be used, subject to the usual objections attending the transfer to the record; there is, however, less liability to error in thermometry recording than some other recording instruments.

For a pressure instrument for such low pressures as usually exist in refrigerating work, a mercury pressure gage will prove on the whole more accurate and less liable to get out of order, than any other type, and frequent readings insure a reasonably accurate average. Sometimes a recording gage is found that will give results comparable to a mercury gage, and although the readings are necessarily coarser they may be close enough for commercial work.

For measuring quantity, the venturi meter has been perfected so as to give results within 1 to 3 per cent of the calculations by brine load. The chances are that this small error will be in favor of the meter. The writer would not hesitate to determine capacity from data obtained from the weight, temperature and pressure of the liquid used and would feel particularly safe with ammonia, the properties of which are almost as well authenticated as those of water.

Considerations herein given cover only capacity. The burning question of horsepower per ton requires a different set of instruments.

Fortunately, where electricity is used for power, a direct relation can be almost instantly established between horsepower and capacity, and if such results are satisfactory and as good as the best, nothing more need be investigated. A reliable ammeter and voltmeter, checked with a reliable wattmeter will give the data necessary to determine the horsepower consumption. These instruments, of course, should be checked occasionally for accuracy the same as one would check any other instrument of accuracy.

Condenser Instruments

To insure that the condensing process is being properly conducted and as a guide to operation, a number of instruments of measure are employed, and all should be of the best, for it must be always kept in mind that an incorrect instrument of measure is worse than none at all.

For every-day convenience a pressure gage to register the back pressure and one to register the head pressure are placed in plain sight of the operating engineer. If an accurate mercury gage is used for the purpose of closely estimating capacity, the working gage should be compared with it from time to time to insure that it keeps fairly accurate. For head pressures reliance is usually placed on the working high-pressure gage and its accuracy should be checked by periodical accurate tests. The temperature of the liquid thermometer is the guide of pressure. It is recommended that a separate scale be added to the pressure gage to show corresponding saturated temperatures.

The head pressure shown by the head-pressure gage in most instances should not be more than 8 or 9 per cent higher than the pressure called for by the temperature of the liquid, and sometimes it runs even closer. Perhaps with very high head pressure it might run a little more, but a difference of 10 to 12 lb. is commercially attainable. If it is farther away than this, it is time to look for foul gas in the condenser or clogged condenser surfaces or insufficient surface.

Thermometers at the Compressor

For complete information a thermometer to record the temperature of the compressed gas as it leaves the compressor is desirable. It is impossible to expect that it will indicate accurately the state of the compressed gas within the compressor cylinder, as many heat transfers may happen before the compressed gas reaches the thermometer. The thermometer will usually give a

*Paper read before the Annual Meeting of the National Association of Practical Refrigerating Engineers, Nov. 2, St. Louis, Missouri.

fair check on the relative condition of the gas and will show when compressor is not functioning properly.

Of the use of the indicator and the lessons to be drawn from its use one cannot do better than refer to books on indicating the compressor, where the subject is treated to a much greater extent than this paper permits. The indicator is an X-ray photograph of the interior of the compressor in action and a sure exposition of its faults and a suggestion of cure.

For commercial convenience the volumetric efficiency of the compressor is often referred to as the relation of its swept displacement (clearance considered) to the evaporative volume. This is really what we desire to know in the final analysis from a commercial viewpoint, but taken alone it is not always fair to the compressor. Therefore, to get at the real facts affecting compressor performance, a thermometer on the suction near the inlet valve is desirable.

Checking the Suction Gas

A whole lot of things might happen to the gas on its way from the coils to the compressor suction valve, and inevitably it might occupy a much larger volume per pound by the time it reached the suction valve over its volume per pound at the evaporator. If the difference is only seven or eight degrees we might commercially neglect it, but if it runs large it is unfair to charge against the compressor acquisition of heat that has probably done nobody any good. The heat so acquired has in all probability not come from the brine or any other place where its removal benefits anyone.

The heat that is thus unprofitably taken up between the evaporator and the suction valve has of course to be raised to a higher plane and eliminated just as if it had done useful work, and it represents, therefore, a dead loss.

To keep track of this loss so that means may be devised to prevent it, at least partly, it is desirable to place a thermometer on the compressor suction to show the temperature of the suction gas when the compressor takes hold of it and compare this reading with the evaporation temperature. Differences of 20 to 25 deg. are not uncommon, and this means an appreciable increase of gas volume handled by the compressor.

Recording Instruments

Recording gages, except, perhaps, temperature recorders, are very likely to get out of order and to present false information on the charts. The trouble is not in the instrument that gives the information, but in the mechanism that attempts to convey this information to a chart. If the error is a constant one, the chart, although not valuable for specific information as to the true state of affairs at any one time, may be valuable for qualitative analysis or comparison. Original readings taken from the instrument are better and surer, especially in a test, and a person making frequent readings often sees things that a chart will not tell him.

As a result of many tests the writer feels almost safe in relying on the amount, temperature and pressure of the working fluid as a measure of capacity, but many plants are equipped for measuring capacity by quantity and temperature of brine, which is of course a reliable method in itself and also gives opportunity for a check on the other method. Both methods are of course, subject to another check, by calculation of gas volume. Aside from estimation of tonnage and horsepower per ton it is desirable to keep track of the temperature and often the quantity of brine. Sight thermometers of the separable-socket type are made that are accurate. A continuous record is of use to the engineer and especially of value to the managers. Care in placing the thermometers is, of course, to be taken to insure that they give the average temperature of the brine.

It can probably be said that there are few recording brine meters that can be absolutely relied on. A venturi meter carefully calibrated for the density of brine employed and the average temperature, would be considered accurate if original readings of pressure differences were taken at the meter tube, but a great chance of error lies in the transmission to the integrator and chart. Measuring by pump piston displacement with allowance for calibrated slip is perhaps as reliable as any method. Record of specific gravity is better taken by a hydrometer with a widely marked specific gravity scale than by some arbitrary scale as the salometer or Baumé hydrometer.

Measurement of inlet and outlet temperature of condensing water and weight of the same is perhaps the quickest and surest way of arriving at efficiency and checking capacity. Where a water pump is used an occasional calibration should be made by discharging into a tank of known volume. A check on the capacity and reasonableness of the horsepower per ton is instantly made by this method.

Condenser Performance

The working conditions of the condenser may, likewise, be checked by thermometers. The head pressure should show a corresponding temperature very close to the temperature of the hottest or outgoing water. Three tests by Horne showed condenser temperatures 7.8 deg. hotter than the hottest water. Four other tests with colder water showed an average of 10.6 deg. hotter condenser temperature than the hottest condensing water.

As a general rough rule one should be pretty well satisfied if the temperature corresponding to condenser pressure is, say, not over five degrees above the temperature of the hottest or outgoing water. So figures obtained from the thermometry and quantity of condensing water are of immediate and great value. The measurement of heat out is equivalent to the measurement of heat in. Absolute fine correctness is little disturbed by reception or loss of heat from the atmosphere in machines over five tons in capacity.

In the Horne test of Oct. 21, 1922, which was a very careful one, the heat out was calculated at 272 B.t.u. per ton. The available heat in for refrigeration was, of course, 200 B.t.u. per ton, leaving 72 B.t.u. for power, or $\frac{72}{42.44} = 1.68$ hp. The actual i.hp. on gas was shown to be 1.666, or an agreement of less than one per cent. Numerous other tests show results nearly as good.

It is only by frequent checking of the actual horsepower input with the theoretical horsepower required under the existing conditions of pressures and temperatures that the engineer is able to keep the costs per ton within reason. Even then the plant may not be operating efficiently, since in many plants the head and suction pressures and temperatures are not what they should be for good performance.

A Check on Steam-Turbine Performance

The Nozzle or Inlet Pressure Used To Determine Relative Efficiency, Total Steam per Hour, and Power Output

By H. M. PHILLIPS*

IN THE ordinary plant little attention is paid to the amount of steam used by small turbines unless one or more units of this size constitute the principal boiler load. A certain make may be purchased for reasons of giving good service, attractive advertisement, skillful salesmanship, or lowest price; steam economy does not appear to be given the consideration that it deserves. If the turbine carries the load satisfactorily after installation, the steam consumption is usually forgotten. When connected to a generator, the latter is sure to be provided with meters, and in many instances hourly readings showing the generator output are recorded. If the turbine operates a pump, a gage is frequently provided on the discharge line for checking pump operation, but there is rarely any way of measuring the steam flow of the turbine, and in the majority of cases the engineer has no check whatever upon the performance.

In many types of small turbines the steam is throttled by the valve gear before it is admitted to the nozzles or blades, as in Fig. 1. The pressure at the inlet, or nozzle port, therefore varies with the load, and if blade deterioration or nozzle erosion takes place, the curve of this pressure, taken with various loads, will differ materially from such a curve of a normal turbine. This is a valuable check on the steam consumption and power output of the turbine.

In other types of turbines steam is received at full pressure at the steam chest and admitted at full pressure through several ports, to a sufficient number of

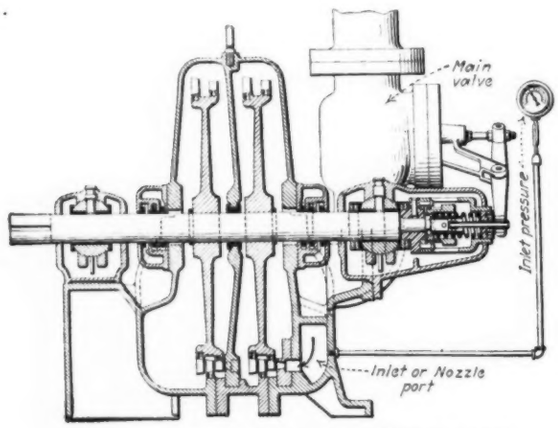

FIG. 1—GAGE ON INLET OR NOZZLE PORT

nozzles to carry the load. Throttling takes place only when an individual nozzle port is being opened up by the valve gear. Here a different treatment will be required, as will be described later.

As soon as a turbo-generator is installed, a curve should be plotted showing the relation between throttled inlet or nozzle pressure and generator output, as illustrated in Fig. 2. This will in all cases be very nearly a straight line; it should, if possible, be checked with similar data furnished by the manufacturer. If this relation changes at any future time, it is a sure sign that something is wrong; it may be the calibration of the

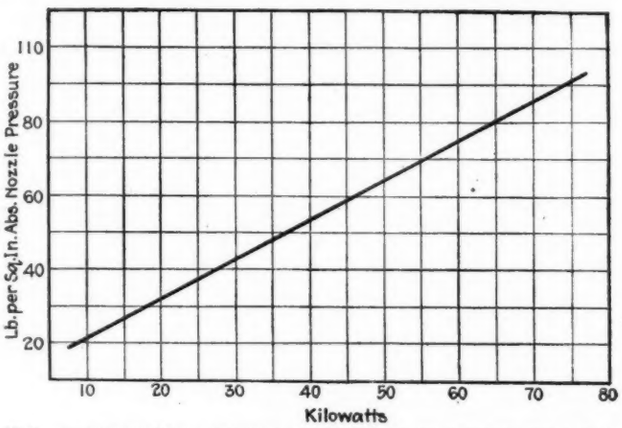

FIG. 2—INLET OR NOZZLE PRESSURE PLOTTED TO LOAD

electrical instruments, wear on the turbine blades, leakage of packing, a change in blade clearance or trouble in the nozzles; at any rate it should be investigated, as a change in nozzle pressure indicates an increase in steam consumption.

If the blades or nozzles or packings deteriorate in the lower pressure region, a higher inlet pressure would ordinarily be required to carry the same load, as more steam would then be necessary on account of lower efficiency. Such a point would appear *above* the line; Fig. 2, if plotted. On the other hand, if the nozzles at the high-pressure inlet, particularly in a single- or two-stage impulse machine, should become eroded so as to increase their capacity considerably, while other elements of the machine remained normal, the turbine would then take more steam for the same inlet or steam-chest pressure, and it is possible that such a condition might produce a greater load-carrying capacity at that inlet pressure giving a point *below* the line, Fig. 2. It seems possible also that both effects might take place in the same relative proportion, so that wear of the high-pressure nozzles might compensate for loss of efficiency in lower stages, and the steam consumption rise, without appreciable rise or fall of inlet pressure, producing a point on the line, at a certain load. Taking a curve of readings at various loads, however, would be expected to show a different curve from that of a normal machine; a case of the latter kind would be so rare as to be hardly worth considering. Generally speaking, the curve of load and inlet or steam-chest pressure resulting from throttling by the valve gear, may be depended upon as a good indication of the general turbine condition.

Even in the case of an old turbine, on which no records have been kept, it is a good plan to take the

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above-mentioned readings at the first opportunity; they may be checked against the manufacturer's information and will show if it maintains the same economy in the future and may give gratifying proof of the benefit obtained when either the turbine or the apparatus that it drives is overhauled.

A curve similar to those shown in Fig. 2 should be obtained from the manufacturer with every new turbine. He should also be able to supply at least an approximate curve for an old one if he is given the serial number and other name-plate data.

Measuring Total Steam per Hour from Inlet Pressure

The inlet gage pressure may further be used as a means of informing the engineer of the total pounds of steam used per hour. Line *A* in Fig. 3 indicates inlet pressure plotted to load, for a 300-kw. 140 lb. absolute condensing impulse turbine; this is a similar line to that plotted in Fig. 2. Curve *B* is the steam consumption per kilowatt-hour, plotted to load. These two curves may be combined into curve *C*, giving the total pounds of steam per hour, plotted to inlet pressure.

As an illustration, suppose that at 200 kw. the inlet pressure is 97 lb. from curve *A*. From the manufacturer we may obtain the water rates at one-quarter, half, three-quarter and full load, sufficient to draw curve *B*. At 200 kw. the water rate from *B* is 22.5 lb. per kw.-hr. The total steam per hour at this load is therefore $200 \times 22.5 = 4{,}500$ lb. steam per hour. Plot this value to the inlet pressure of 97 lb. A few such points determine the straight line *C*.

The points plotted correspond fairly well to a straight line except for light loads. It will be seen that they correspond exactly from half to full load; this can be used for approximately obtaining the total steam per hour at any time, from half to full load. The curve *C* may be obtained directly from the manufacturer, or calculated by the engineer from water-rate curve *B* combined with the line *A* made by taking readings in the power house.

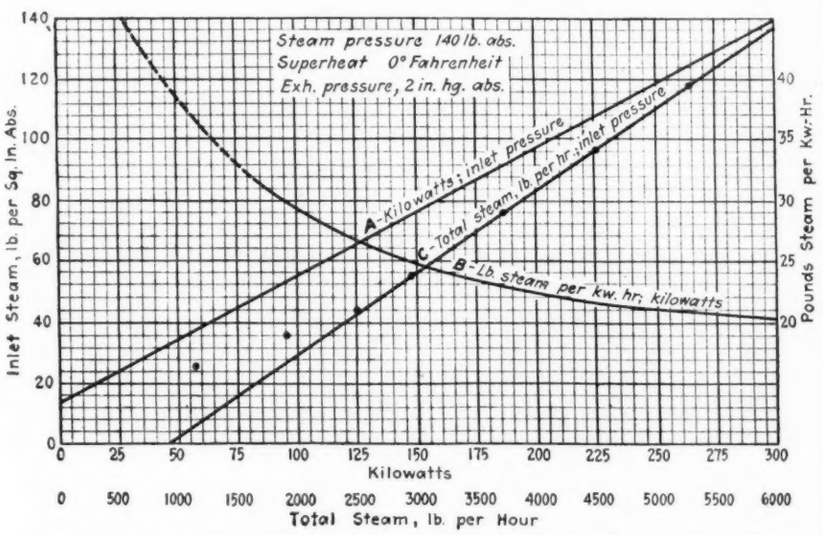

Steam pressure 140 lb. abs.
Superheat 0° Fahrenheit
Exh. pressure, 2 in. hg. abs.
A-Kilowatts; inlet pressure
C-Total steam, lb. per hr.; inlet pressure
B-Lb. steam per kw. hr.; kilowatts
Inlet Steam, lb. per Sq. In. Abs.
Pounds Steam per Kw.-Hr.
Kilowatts
Total Steam, lb. per Hour

FIG. 3—TOTAL STEAM PER HOUR DETERMINED FROM INLET GAGE

Steam pressure and vacuum seldom correspond exactly with guaranteed conditions, so this represents approximate results unless the engineer is particular to obtain guaranteed conditions when making the test. Ordinarily, the usual correction factors for steam and exhaust conditions may be applied in order to check more closely with guaranteed requirements. For variations in steam pressure, turbines at 100 lb. gage change approximately 1.4 per cent in water rate for

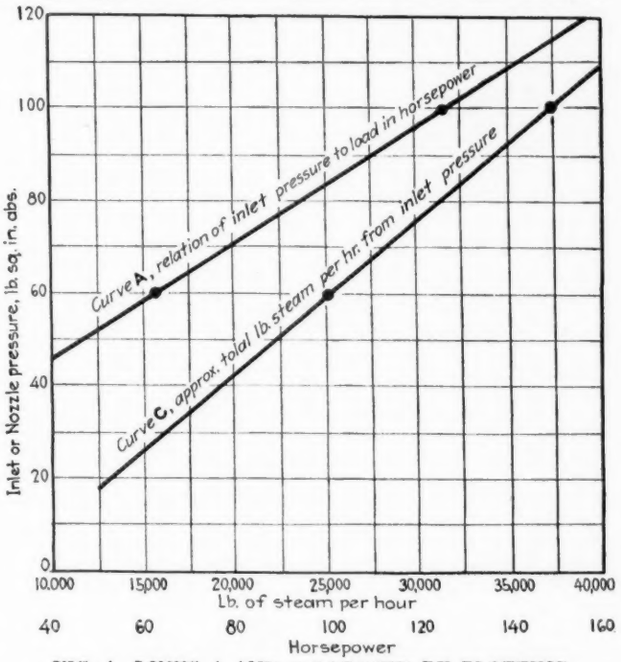

Curve A, relation of inlet pressure to load in horsepower
Curve C, approx. total lb. steam per hr. from inlet pressure
Inlet or Nozzle pressure, lb. sq. in. abs.
Lb. of steam per hour
Horsepower

FIG. 4—LINES *A* AND *C* LOCATED BY PLOTTING TWO POINTS IN EACH

10 lb. change in steam pressure; at 150 lb. gage, 0.9 per cent for 10 lb.; at 200 lb. gage 0.7 per cent for 10 lb.; at 250 lb. gage, 0.45 per cent for 10 lb. For variations in superheat allow 5 per cent for each 50 deg. F. up to 125 deg. superheat and 4 per cent for each 50 deg. above this. Vacuum changes approximate 5 per cent for each inch referred to a 30-in. barometer; double this amount for low-pressure turbines.

Back-pressure variations in noncondensing turbines amount to 2 per cent for each pound. These corrections refer only to approximate results, such as the engineer could use as a general check in the case of small turbines where steam-flow meters would be regarded as an unjustifiable luxury. Manufacturers can usually supply more accurate correction factors suitable to the turbine in question.

The load produced by a pump or fan is much more difficult to measure than that of an electric generator. In some few cases it may be possible to figure the delivered energy conveniently, but ordinarily a definite load must be located by means of pump pressure, fan speed, discharge-valve opening, maximum flow or some other factor or combination, for recording the inlet pressure under these conditions. Several such points, each indicating a definite turbine load, should be used for recording the inlet pressure, and the readings checked at desired intervals for indications of deterioration of turbine or driven machine. An engineer may compare the inlet gage with known load points, in his

regular round of duty, and thus get a mental impression of the turbine condition.

Curves as in Fig. 3, when plotted to horsepower instead of kilowatts, will make it possible to determine both the horsepower expended and the steam required per hour, at the known load points. Suppose a 125-hp. 125-lb. absolute steam non-condensing turbine is placed in operation and the manufacturer advises that at full load the water rate is 29.5 lb. per hp.-hr., inlet pressure 100 lb. absolute, while at half load the water rate is 40 lb. per hp.-hr., inlet pressure 60. Curves *A* and *C*, Fig. 4, could then be plotted by drawing straight lines through the two points obtainable: 100 lb. inlet pressure to 125 hp. and 3,690 lb. per hour; 60 lb. inlet pressure to 62.5 hp. and 2,500 lb. per hour. The actual horsepower and steam per hour for a new turbine could then be determined at any load point above half load. Gage pressures may be used instead of absolute pressures.

Instances Where Inlet Pressure Cannot Be Used

The inlet or nozzle-port pressure gage cannot easily be used for a turbine equipped with a number of valves and inlets or nozzle ports. The variation of all inlet pressure would then be a very complicated and unsatisfactory record to handle. A good alternative is to place a gage after the first expansion takes place. The curves *A* and *C* will then depart more seriously from a straight line, so that a larger number of points are desirable for locating these curves. A gage can often be tapped conveniently at the cylinder or wheel casing where a drain is connected. A gage tapped into the last inlet to be opened at maximum load would give the same results, except that a large increment of pressure would occur on the opening of this inlet, producing more irregularity in curves *A* and *C*.

It should be borne in mind that failure to carry load may not always result from turbine deterioration. Conditions of steam pressure, exhaust or vaccum should be carefully checked. A shot of water will temporarily slow down a machine. If the strainer in the steam pipe becomes stopped, the inlet pressure and speed will drop at a given load, or else the machine will "fall down" completely, depending on the amount of the stoppage and the load at which the measurement is made.

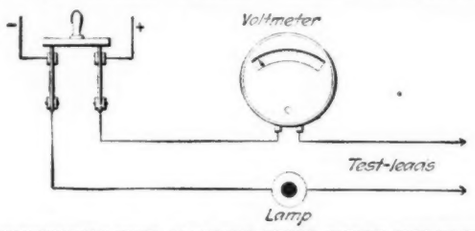
Ground on Control Wiring Caused Oil Switch to Close

By Ralph Brown

In a power station it was discovered that a motor-operated oil switch normally open would close of its own accord, generally within a few minutes after being opened by the operator, and on two or three occasions the operation of this switch caused the opening of an adjacent switch which was supplying an important feeder. The trouble was finally attributed to the control wiring, and when it was examined a pull box near the oil-switch cells was found to contain water, and the insulation between conductors had consequently failed. It was then remembered that a slight ground, which had disappeared before it was located, had been indicated several weeks previously, and the water in the pull box undoubtedly caused this ground. When the oil switches operated of their own accord, no ground was indicated by the ground lamps, yet sufficient current flowed between conductors immersed in the water to operate the switches.

From this it appears that any indication of a ground must be considered as a warning of probable trouble, hence the cause of such an indication should be ascertained without delay. Even though ground lamps indicate that a circuit is free of grounds, testing by a voltmeter might prove otherwise. The pull box referred to contained water because an unfastened window above it permitted rain and snow to strike the floor, an inspection should have disclosed this faulty condition. However, pull boxes should be watertight or, preferably, placed only on walls above the floor. Little expense was incurred in replacing the defective control wiring and in repairing the window, but the trouble described resulted in several avoidable interruptions to service.

To test for grounds or poor insulation between conductors, a good way is to connect a voltmeter into the test circuit, as in the figure. The lamp is connected in as a precaution against making a short-circuit.



CONNECTIONS FOR MAKING TEST WITH VOLTMETER

When one side of the test circuit is grounded, the voltmeter should be connected to the ungrounded side, then the lamp leads are used only to insure a return circuit. In testing the insulation of a wire to ground, the voltmeter lead is placed on the wire and the lamp lead on the conduit. To make an insulation test between two wires, the voltmeter lead is connected to one wire and the lamp lead to the other. The test to ground should be made first to preclude the possibilities of obtaining a reading to ground when making the test between conductors. If the insulation is in good condition, a reading of not over 4 or 5 volts should be obtained in any case, and if the wiring system is small a zero reading should be obtained.

Rubber Used for Seal Rings of Hydraulic Turbines

Water leakage between the turbine runner and the stationary casing is an important item of loss, especially where units operate at high heads. Ordinarily, labyrinth packing is employed, which causes the water to take a very circuitous path and be subjected to close clearances. Abrasive material contained in the water, however, has a disastrous effect on such metallic packing, and is the cause of objectionable repairs. Solid matter jamming in such clearances may cause the revolving parts to bind or run out of center.

Rubber seal rings being flexible, eliminate a great deal of the trouble encountered, reducing the wear almost to a negligible amount. They are fitted to give material contact with the shaft, the water film acting as a lubricant. Rubber of the consistency of that found in the outer casing of an automobile tire has proved the most satisfactory, after a year of experimenting by the Pelton Water Wheel Co. A slight gain in power by the use of these rings has been noticed at the Kaweah No. 2 power house of the Southern California Edison Company.

The Two-Stroke-Cycle Diesel's Superiority for Large Powers

By EDVIN LUNDGREN*

THE author, who has had an extensive experience in Diesel-engine manufacture, discusses the points of superiority of the two-stroke-cycle engine, illustrating it with data on the Nobel-Sweden 1,600-hp. Diesel.

IT IS the belief of many engineers that the two-stroke-cycle Diesel engine in the large powers has no advantage over the four-stroke-cycle engine in the matter of economy and space, amount of mechanism, first cost and weight. Dr. Charles Lucke, in his discussion on "The Oil Engine of Today," in *Power*, Aug. 15, 1921, voiced this common view in stating that in large sizes the difference between the four-stroke-cycle and two-stroke-cycle engines, as to amount of mechanism, was not great nor was there much difference in cost or weight per horsepower. This statement may be true for certain designs, but is not correct for all two-stroke-cycle engines. To bear out this contention, data and actual figures about the new two-stroke-cycle engine, built by the Nobel-Diesel Co. in Nynäshamn, Sweden, and shown in the accompanying illustrations, are given here.

The engine is a four-cylinder two-stroke-cycle Diesel with a cylinder diameter of 26.57 in. and a piston stroke of 36.2 in. At a speed of 105 r.p.m. it develops 1,600 b.hp. and must therefore be counted among the large Diesel engines. As usual with these large sizes, the engine is provided with crossheads and guides. The scavenging air is furnished by two double-acting air pumps; a slowly rotating piston valve performs the functions of the suction and pressure valves for each pump. The compressed air for the fuel injection is furnished by a three-stage air compressor. The scavenging pumps as well as the compressor, all of which are located along the side of engine, are driven by means of rocker arms and links attached to the crossheads of the engine, as illustrated in Fig. 2, where the pump rocker arm is shown linked to the end crosshead. This arrangement, while increasing to a slight extent the width of the engine, reduces the length by a considerable percentage. Although the engine is of a conservative design throughout and all parts are figured with an ample factor of safety, corresponding to the rules of the British Lloyds, the total weight of the whole engine, including a 13-ton flywheel, is but 188 tons, or 236 lb. per brake horsepower. A four-stroke-cycle engine of a standard design like the Burmeister & Wain, built by the Cramp Shipbuilding and Engine Co. in the United States, developing the same power at the same speed, has six cylinders and weighs not less than 350 lb. per b.hp.; this is 50 per cent more than the weight of the Nobel two-stroke-cycle engine. This means more than a mere reduction in the weight to be supported by a foundation or by a ship's timbers. The 50 per cent reduction in weight permits the builder of a two-stroke-cycle engine either to sell the unit at a lower price than is possible in case of a four-stroke-cycle engine, or if the selling price remains the same the grade of machine work and material entering into the construction of the two-stroke-cycle engine may be better than in its rival. In these days of keen competition, not only among builders of a single country but among the builders of many nations, the item of manufacturing costs in most instances determines to whom the contract will be awarded.

With regard to mechanical simplicity this two-stroke-cycle engine is evidently superior to the four-stroke-cycle engine. There are no inlet and exhaust valves with all their gearing, but on the other hand, there are the scavenging pump with the one rotary valve and the one scavenging-air controlling valve for each cylinder. It is to be observed that the mechanical simplicity is particularly pronounced where the engines are reversible.

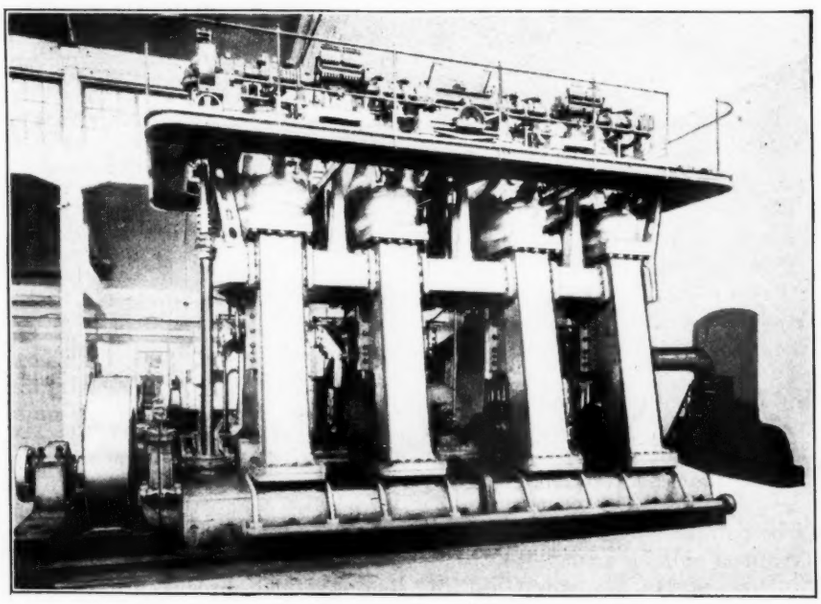


FIG. 1—1,600-HP. NOBEL TWO-STROKE-CYCLE DIESEL

It must be pointed out that the Nobel engine has disproved the claim made by Dr. Lucke that the two-stroke-cycle engine does not succeed in giving so full a charge of air to the cylinder with the same power as the four-stroke-cycle engine. At normal load the mean effective pressure, not the indicated, of the Nobel engine, was 74 lb. per sq.in. and at 25 per cent overload—that is, at 2,000 b.hp., which the engine was de-

*Consulting engineer, Stockholm, Sweden.

veloping continuously for three-quarters of an hour—the mean effective pressure was 90 lb. per sq.in. During the official test, which included a continuous 24-hour run, the fuel consumption was found to be 0.395 lb. of oil per brake horsepower-hour, which is fully as good as that of any first-class four-stroke-cycle engine. At lower loads the engine shows even a better fuel consumption than a four-stroke-cycle engine; at half load, for instance, the test gave 0.42 lb. per brake horsepower-hour.

The actual performance of the Nobel engine during the official test, which was made under the supervision of a professor of the Technical University of Stockholm, shows conclusively that all the theoretical advantages

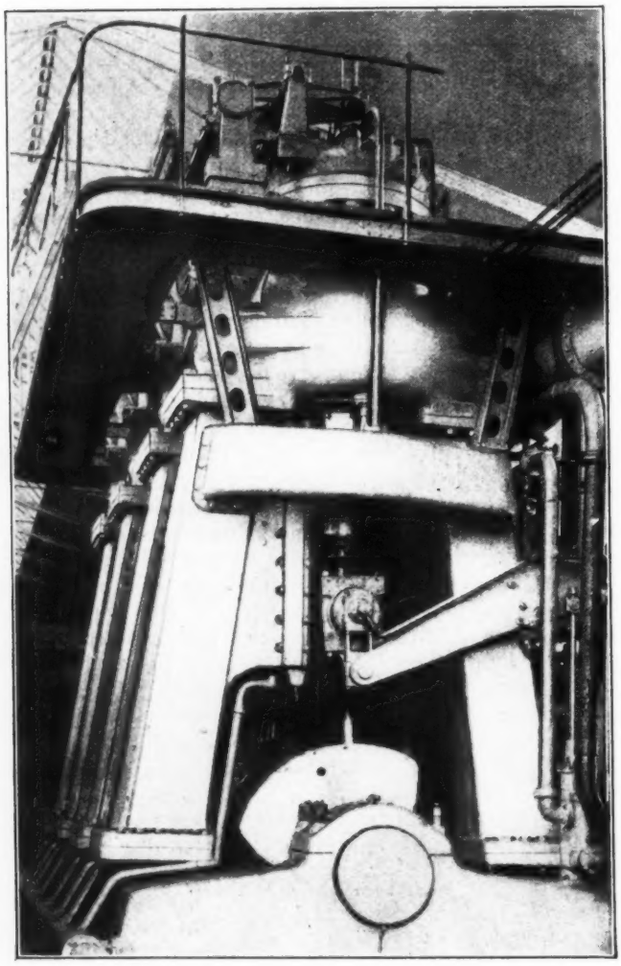


FIG. 2—CLOSE-UP VIEW OF ENGINE FRAMING

of a two-stroke-cycle engine may be attained in practice, that one cylinder of the two-stroke-cycle engine may be able to develop twice the power of a four-stroke-cycle cylinder, and that a considerable saving of weight and space is possible by the adoption of the two-stroke-cycle principle.

It is, however, to be remembered that the design of a two-stroke-cycle engine, although it is mechanically simpler than the four-stroke-cycle, requires far more skill and experience that the comparatively simple design of its competitor.

In conclusion it may be pointed out as an interesting fact that it is quite a common opinion among European engineers that the two-stroke-cycle is predestined to become predominant, particularly for large sizes, as it enables the building of engines for larger power with a lesser number of cylinders than the four-stroke-cycle. Indeed, the latter engine seems already to have reached its limit in size, the largest becoming very clumsy and cumbersome and a larger cylinder diameter than about three feet cannot be considered at the present time as mechanically safe. Double-acting engines involve many very difficult problems of design, as, for example, the piston rod which must go through the combustion space with its exceedingly high temperatures, the stuffing box which must withstand high temperatures and high pressures, the difficulty of providing for a suitable shape of the combustion space on one side of the piston, and finally, that of properly injecting the fuel into this part of the cylinder. In order to gain more power out of one cylinder, there consequently remains only the two-stroke-cycle, and the trend of the development seems to point in this direction. Even in the United States the majority of Diesel engines above 1,000 hp. are two-stroke-cycle.

More Information Is Needed on Wire Rope for Elevators

By Howard B. Cook
Engineering Department, Warner Elevator Manufacturing Company

The stretch of elevator cable in service has not been given the consideration it warrants, and it appears possible that this factor, probably better called permanent elongation, may be an indication of the cable's condition. Information available on several cables used in mine service gives the stretch or elongation during the life of the cable, but does not indicate whether this stretch is constant or variable with respect to time of service. The percentage of increased length varies between the extremes of ½ per cent and 8 per cent. The general average, however, appears to be about two per cent. These cables are of high tensile strength, but these values should give some idea as to what to look for in the stretch of elevator cables.

T. C. Tweedie, of the MacWhyte Co., has stated that the permanent stretch of swedes-iron cable will average 0.7 per cent when the load is applied for the first time. It has been stated by others that there will be a stretch of ½ per cent during the first week of service. A valuable service would be rendered those interested in this subject if several complete records were made of the stretch of cable in service with a view to determining the relation, if any, between cable stretch and cable life.

Elasticity a Factor in the Life of the Cable

The elasticity of the cable appears to be an important factor in determining its life. The tensile strength apparently decreases shortly after installation and increases later. Frank H. Probert, "Trans. A. I. M. E.," Vol. XXX, page 1020, states that "the strength slowly fell away from the first to the sixth month, then increased gradually from the sixth to the twentieth month, after which the strength gradually decreased."

On page 119 of Bulletin 75 of the United States Bureau of Mines, it is pointed out that "when a new rope is installed, there is likely to be a short period while the rope is taking its set and equalizing tension, during which breaks are relatively frequent. These breaks are of no importance and do not indicate that

the rope is wearing out. After the period of their occurrence the rope will run for some time without more wires breaking. Toward the end of the life of the rope, however, it may happen that the number of breaks begins to increase rapidly. Thus inspection on one day may show one wire broken at a certain point. The next day two may appear there and the third day, three or four. This condition arising is a sign that the rope is going to pieces and should be taken off forthwith."

The previously mentioned facts have been observed by many users and inspectors of wire rope, and these conditions may lead to a definite determination of the proper time to discard the cable.

The determination of the modulus of elasticity of the cables on an elevator may present some difficulty. The temporary elongation of a ⅝-in. 6x19 cable 100 ft. long will not be more than 1 in. per 1,000 lb. load, and although this length might be measured with a fair degree of accuracy, slight changes in the elasticity could be determined only by the most careful measurements if the cable is not long. It will be almost impossible to make comparisons between different ropes, operating under varying conditions, unless some definite determination be made of the degree of deterioration that should be permitted before removal becomes necessary.

Rules for Discarding Cables

One of the most definite rules for discarding cables has been formulated by the United States Bureau of Mines and appears on page 46 of Bulletin 75 and states: "The factor of safety of all such ropes or cables when newly installed in shafts less than 3,000 ft. deep, shall in no case be less than six, and shall be calculated by dividing the breaking strength of the rope as given in the manufacturer's published tables, by the sum of the maximum load to be hoisted, plus the total weight of the rope in the shaft when fully let out. It shall be unlawful to use any rope or cable for raising or lowering of men when the factor of safety, based on its existing strength and dead load, shall have fallen below 4.5. It shall be unlawful to use any rope or cable of the so-called 6x19 standard construction for raising or lowering of men, either when the number of broken wires in one lay of said rope exceeds six, or when the wires on the crown of the strands are worn down to less than 65 per cent of their original diameter, or when the superficial inspection, provided for in this section, shows marked signs of corrosion. Provided, however, that when such broken wires are reduced by wear more than 30 per cent in cross-section, the number of breaks in any lay of the rope shall not exceed three."

Bending Cause of Cable Deterioration

Bending is probably the most important cause of elevator-cable deterioration. This factor is influenced chiefly by drum diameter and cable diameter or, what is more probably correct, wire diameter.

Drum diameter determines the bending stress, but the effect of the bending stress on the life of the cable has never been evaluated. The determination of the economic drum diameter is important. Increasing the size of the drum will increase the cable life, but will the increased cable life justify the increased cost of the winding engine and the increased cost of operation due to the decreased efficiency of transmission? The entire problem is one of economics, and any gain in one direction that is neutralized by a loss in another direction, is of no value.

Elevator-cable diameters have been reduced from ⅞ to ¾ in. through successive stages in the past. Will the standard cable eventually be reduced to ½ in. diameter. Is there any economic gain in the use of six cables when four will give an adequate factor of safety?

Impact is another factor. It occurs at every start and stop of the elevator. It is affected by the weights that are started and stopped. The length of the cable will also influence this factor.

It is known that there is a wide variation in the life of cables on elevators. One set of cables will last three times as long as another when the conditions appear to be the same in both cases. Whether this variation in cable life is due to variation in manufacture or to variation in impact or some other hitherto unnoticed cause, it is difficult to say.

The cables are supported in the same manner on a U-groove traction, drum traction, and a drum-type machine. It is also probable that variation in tensions between the cable on these different types of drive does not greatly influence the life of the cables.

It is believed, however, that the conditions are different on a V-groove drive. If the distance of the center of the cable from the center of the drum varies, either due to variation of cable diameter or to inaccurate machining of the grooves, then there will be a variation in movement between the different cables, which, unless compensated, may become an important factor.

Lubrication of Cables

Lubrication is undoubtedly a factor. It may be, however, that the lubricant placed in the core at the time of manufacture is sufficient for all practical purposes, and the subsequent application of a lubricant to the exterior of a cable may be of little value.

An elevator cable must finally be discarded because of fatigue in the metal, and it might be possible to increase the life of an elevator cable by the use of those alloy steels that have proved so successful in other industries. Such cable, however, must justify itself from an economic standpoint.

The speed at which a cable travels is a factor the value of which has not been determined. The value of any factor can be determined only by keeping all other factors constant and varying the one to be determined.

Elevator manufacturers, cable manufacturers and cable users should all co-operate in the collection of accurate data and the determination of proper tests in an endeavor to learn the facts. The greatest care should be exercised in drawing conclusions, for much harm will result from careless assumptions.

Only the water in storage-battery electrolyte evaporates, and this is due to its being exposed to the air, and also to the gassing during charge when some of the water is decomposed by the charging current and escapes in the form of gas. This must be replaced from time to time. The cells must be kept filled to within one-half inch of the top of the glass jar. The best time is just before the beginning of a charge, and if necessary the cells must be filled before the beginning of every charge. The surface of the electrolyte must never be allowed to fall below the top of the plates or the exposed portion will be badly damaged. Distilled water in general should be used to make up the evaporation, although some natural waters are pure enough to be used, but this must be determined by a chemical test, which may be made by the storage-battery company.

A Review of Feed-Water Treatment*

SO MANY different methods and ideas have been brought out in the series of articles on feed-water treatment, that something in the nature of a summary seems to be called for. It is the purpose of the present review to present such a summary and to do it in such a way that the various methods of treatment can be made to fit more or less into a single picture. While the attempt to compress so much into a single article will make it necessary to omit many details, that in itself will be an advantage, in that it will help the reader to get the broader viewpoint which is desirable in approaching problems of this nature.

This review will consider the various methods of treatment in the following order, which differs from that in which the articles were originally presented: (1) Distillation, (2) chemical treatment, (3) zeolite treatment and (4) corrosion prevention. The treatment of feed water is mainly to eliminate or reduce the following troubles: (1) Scale and other solid matter in boilers and piping, (2) priming and (3) corrosion. Scale is caused by "hardness" in the water. This consists chiefly of the dissolved compounds of calcium and magnesium, which are thrown down at boiler temperatures and concentrations along with much of the mud and other undissolved impurities in the feed water. The loss and inconvenience due to the collection of scale and mud in boilers is too well known to require elaboration here.

THAT necessity is the mother of invention has been proved many times in the field of feed-water treatment. Power-plant engineers are not often chemists or physicists, but when nature handed them, along with a bountiful supply of natural water, some of her knottiest problems in the shape of scale and corrosion troubles, they found a way out. Of course they did not accomplish this alone. Help was asked and received from the chemists and other scientists. But the fact remains that the problems were, to a large extent, solved. In a series of articles, which the present review concludes, *Power* has tried to show, in an impartial fashion, what these solutions are. The purpose of this review is to wind up the series by co-ordinating the information that has been given on the various methods of treatment.

In the past dissolved solids, particularly sodium compounds, have been generally considered as the main cause of priming. However, there is now a considerable difference of opinion on the subject, many engineers claiming that priming will not occur even with high concentration of dissolved solids, provided that such undissolved impurities as mud, oil and particles of scale are absent. At any rate there is no doubt that the removal of the undissolved impurities is of great value in preventing priming.

Corrosion is a source of much trouble, particularly in boiler-feed lines and steel-tube economizers. In ordinary water many substances seem to have a marked effect on the rate of corrosion. Among these are carbon dioxide, the chlorides of calcium and magnesium, organic acids, etc. These were often referred to in the past as the cause of corrosion. Probably there is no one "cause," but there is one link in the chain of causes that seems to be essential in almost every case. That is the dissolved oxygen. It has been demonstrated that, with practically any natural water, corrosion stops if the oxygen is removed. It is then seen that the other "corrosive" agents are important only in the presence of oxygen. Oxygen, however, is always picked up by water that comes in contact with air, so that all natural waters contain some of it in solution, and are therefore corrosive.

Of the various methods of treatment that of distillation removes practically all the impurities, including most of the dissolved oxygen. It must not be thought, however, that an evaporator will necessarily prevent corrosion. It removes much of the oxygen from the makeup water, but there is still the possibility of the main body of condensate being contaminated with air on its way to the boiler. That the distilled water produced by evaporators is ordinarily free from any substances that could cause appreciable scale or priming is practically undisputed. It is also undisputed that there are certain waters where evaporators constitute the only possible treatment. A good example is sea water, which contains a high concentration of sodium compounds. For impurities other than the sodium compounds there is available the treatment by chemical reagents, usually lime and soda, and that by zeolites. Both of these processes are normally combined with filtration to remove undissolved impurities. Leaving out of consideration the case of sea water and certain inland waters high in sodium compounds, there remains a wide field where either evaporators, the lime-and-soda process, or the zeolite process may be used, and where some engineers would use one and some another. With a few exceptions it is not possible to lay down any hard and fast rule as to which kind of treatment should be used for a given type of installation. That must be decided by a careful consideration of the needs and possibilities of the particular plant under consideration.

It is, however, possible to point out the general influence of certain factors as affecting the desirability of the various kinds of treatment. Before doing this it will be well to review briefly the outstanding facts about the various methods of treating feed water.

Evaporators

Evaporators may be classified (1) by the number of effects, as "single-effect," "double-effect," "triple-effect," etc., (2) by the pressure of the steam supplied, as "high-pressure" (live-steam) or "low-pressure" (exhaust-steam), (3) with high pressure, as "high-heat-level" or "low-heat-level," according to whether the last-effect vapor gives up its heat to the feed water in the range above or below 212 deg., and (4) according to the construction and operation of the individual effects, as "submerged-tube," "film-type," "flash-type," etc.

*The following articles have appeared in the series on feed-water treatment: "Softening Boiler Feed Water with Zeolites," Sept. 12, 1922; "Evaporators in the Stationary Power Plant," Sept. 19; "Corrosion—Its Cause and Cure," Oct. 3; "Corrosion—Apparatus to Prevent It—I.," Oct. 24; "Corrosion—Apparatus to Prevent It—II., Nov. 7; "How the Lillie Evaporator Operates," Nov. 21; "The Flash Evaporator," Nov. 28; "The Chemical Treatment of Feed Water," Dec. 19.

Taking up first the question of the proper number of effects, increasing the number gives almost a proportional increase in the amount of makeup produced per pound of steam supplied. While the exact figures vary considerably with the conditions, the distilled makeup produced per pound of steam supplied averages about 0.8 lb., 1.5 lb., 2 lb. and 2.4 lb., for one, two, three and four effects respectively.

If the heat in the steam supplied were wasted, it would obviously pay to keep on adding effects until the value of the steam saved by the last effect added just equaled the additional yearly investment and operating charges. As a matter of fact a certain amount of heat can always be absorbed by the feed water, so that the number of effects is determined in part by the amount of heat that can be so absorbed at various plant loads with the type of evaporator under consideration. Ordinarily, at least two effects are used, aside from any theoretical considerations, to provide needed flexibility and to permit operation when one effect is down for cleaning.

Finding Proper Number of Effects for Low-Pressure Evaporators

Let us consider first the case of a low-pressure evaporator operated by exhaust steam that, before an evaporator is installed, goes directly to heat the feed water. With the evaporator practically the same amount of heat (minus radiation and blowdown losses[1]) is available in the last-effect vapor to heat the feed water. This heat, if introduced into the main condensate by using the latter as cooling water for the evaporator condenser, will raise the feed temperature by an amount corresponding to the weight of the steam supplied to the evaporator, which is less as more effects are used. As the temperature of the last-effect vapor necessarily depends on the temperature of the feed water leaving the evaporator condenser, it is evident that the "temperature head" on the evaporator (the difference between the steam temperature and that of the last-effect vapor) is greater the greater the number of effects. Too few effects, particularly at low loads and in a plant requiring a large amount of makeup, might reduce this temperature head to such a point that a prohibitively large and expensive evaporator would be required. Too many effects would run up the cost again by reducing the temperature drop in each effect.

The proper number of effects can, therefore, be determined only by assuming that two, three, etc., effects are used, and figuring out for each case (and for full and part loads) the last-effect vapor temperature and the required size and cost of the evaporator needed to transfer the given amount of heat with the resulting "temperature head." This and other evaporator problems are illustrated by simple numerical examples in the evaporator article in the Sept. 19 issue of *Power*.

What Determines Choice Between "High Heat Level" and "Low Heat Level"

The high-pressure evaporator, if properly chosen for the given plant, also returns to the feed water practically all the heat in the high-pressure steam. If the available exhaust steam is not sufficient to heat the feed water to 212 deg., the heat level from the temperature of the exhaust-steam-heated water up to 212 deg. is available for absorbing the heat in the last-effect vapor.

If this "low-level" range is not large enough to absorb heat with a reasonable number of effects, or if an excess of exhaust steam eliminates this range entirely, the evaporator condenser (or feed-water heater) can take the feed water at 212 deg. or below and raise it into the "high level" above 212 deg., thus returning the heat to the feed water without displacing any exhaust steam, even if there is an excess of the latter. This is called "high-heat-level" operation.

The cheapest and best high-pressure arrangement can be determined by calculations similar to those used for the low-pressure evaporator. Then the cost of the best high-pressure combination can be compared with that of the best low-pressure combination, and due allowance can be made for the various advantages and disadvantages of the two types for the given conditions.

High-Pressure Versus Low-Pressure Evaporators

Frequently, for the same capacity, the low-pressure evaporator must be larger on account of the smaller available temperature drop. It is also necessary to make provision for removing condensate and air under a vacuum. The chief advantages of the low-pressure type are reduced temperature of the blowdown and softer scale due to lower operating temperatures.

With high-pressure evaporators provision is usually made for cracking off the scale by alternating steam and cold water in such a manner as to produce sudden temperature changes in the tubes. In low-pressure evaporators of two or more effects the scale may also be removed by reversing the order of effects, thus changing the temperatures in all of them. Another type, the flash evaporator, gets around the scale difficulty by accomplishing the evaporation in a separate flash chamber away from the water-heating tubes.

All types of evaporators remove most of the air from the makeup water. This will reduce corrosion if air is prevented from entering the main supply of feed water before it gets to the boilers. This question of preventing corrosion will be considered more fully later in the present article.

Evaporators reduce the total solids contained in the makeup to practically zero. The nature of these solids and the amount contained in the raw water have but little effect upon design, first cost or operating cost. With chemical or zeolite treatment the composition of the water has an important effect upon both first cost and operating cost.

Chemical Treatment of Feed Water by the Lime-and-Soda Process

The usual chemical treatment (outside of the boiler) is by the lime-and-soda process. Here the reagents are supplied—usually automatically—in such quantities as to precipitate most of the hardness. With proper treatment this is accompanied by a considerable reduction in the total weight of dissolved solids. Most of the precipitate is removed by settling and occasional blowing down, the remainder being taken out by filters. The treatment may be accomplished with either hot or cold water, the first arrangement being common in boiler-room practice, where the feed water must be heated in any case. Hot treatment speeds up the process and thus permits the use of smaller tanks. It also reduces slightly the amount of reagents required if

[1] Strictly speaking, the heat in the condensate from the various effects must also be subtracted, but this has little effect upon the heat balance as it is returned to the feed water.

there is much temporary hardness, since some of the temporary hardness is thrown down by heat alone.

Cold treatment, on the other hand, permits the use of the batch system, in which the treatment can be accurately adjusted to the impurities in each batch of raw water. Blowdown heat losses are also absent in the case of the cold system. This may or may not decrease the total plant blowdown loss.

Zeolite Treatment

The zeolite treatment consists in passing the water—usually cold—through the sand-like zeolite, which, without dissolving or causing any precipitation, turns the hardness into practically the same weight of non-scale-forming sodium compounds. A filter is used ahead of the zeolite treatment to remove oil and other undissolved impurities. The zeolite itself is not consumed, but must be regenerated from time to time by exposure to a brine of common salt. In comparing the zeolite process with lime-and-soda treatment, the following advantages and disadvantages are taken into consideration:

Comparison of Chemical and Zeolite Treatment

The lime-and-soda treatment sometimes reduces the total weight of dissolved solids, whereas the zeolite treatment does not. The zeolite treatment, on the other hand, removes all the hardness, whereas a small amount of residual hardness remains after the lime-and-soda treatment. The small blowdown heat loss with hot lime-and-soda treatment is absent with zeolite treatment.

The relative cost of reagents varies with the exact composition of the water. Usually salt (for zeolite regeneration) costs more than lime for the treatment of temporary hardness, while the reverse is true of salt versus soda for permanent hardness. Where the water is relatively high in temporary hardness—a condition that favors the lime-and-soda over the zeolite process—a combination system is sometimes employed wherein lime is used to precipitate most of the temporary hardness while the permanent hardness (along with the remainder of the temporary hardness) is removed by the zeolite treatment.

Distillation Compared with Other Methods

In comparing the chemical and zeolite processes with evaporators, the chief advantage of evaporators is the complete removal of all solids, scale-forming or otherwise. As already stated, this makes evaporators the only practical treatment in the case of sea water and land waters with an extremely high sodium content. With waters of average sodium content the total elimination of solids is generally considered a matter of importance in plants where boilers are operated at high ratings. In such plants the choice between evaporators on the one hand and chemical or zeolite treatment on the other is usually made by seeing to what extent the additional saving due to distilled makeup is offset by additional investment charges, heat losses and labor costs. One of the determining factors in this comparison is the percentage of makeup, a small percentage tending to reduce the cost of evaporating equipment.

Methods of Preventing Corrosion

The next thing to consider, as a somewhat separate division of the feed-water problem, is the question of corrosion. Until a few years ago little attention was paid to this, but various corrosion difficulties in modern plants using feed water of relatively low temperatures focused attention upon this subject and resulted in the development of several types of apparatus to prevent corrosion. These operate by removing either the dissolved oxygen alone or all of the dissolved gases, including oxygen. As already explained, water free from dissolved oxygen cannot ordinarily cause corrosion.

Air Removal by Open Heater

A well-vented open heater is a fairly good means of removing dissolved gases as long as the final feed temperature is close to 212 deg. The reason is that the solubility of gases depends on their partial pressures, and that the partial gas pressure necessarily approaches zero as the vapor pressure approaches the total pressure over the water. The open heater will deaërate effectively at temperatures well below 212 deg. if it is operated under a vacuum corresponding to the temperature and if sufficient agitation is provided to sweep out the entrained air bubbles. This method is employed in one type of deaërator. Others, also depending upon maintaining a vacuum corresponding to the water temperature, obtain the necessary agitation by flashing the hot water into the vacuum space or by spraying it over steam-heated tubes.

An entirely different method of preventing corrosion is to remove the oxygen only, by passing the water over finely divided iron. This deactivating action is much more rapid at fairly high temperatures. At lower temperatures it is sometimes used in connection with a deaërator working on the vapor principle, the latter removing most of the gases, while the deactivator takes out the remaining oxygen.

Balancing Corrosion Loss Against Investment

The desirability of installing any of these appliances for preventing corrosion can easily be determined by balancing the loss due to corrosion against the investment charges on the apparatus. As a rule the operating charges are of little importance, as the action is practically automatic, and the heat in the steam used is returned to the feed water with only a slight loss in "head." With any device for the removal of oxygen or dissolved gases it is important that all parts of the steam and water system that are under vacuum be so constructed and maintained that no air can enter. Otherwise the work done by the deaërating or deactivating apparatus will all be wasted.

From what has been said it is apparent that the problem of feed-water treatment is by no means simple. It is one of those subjects that is forced upon the power-plant engineer by necessity, one that he must consider whether his natural inclination runs in that direction or not. In most cases it will be necessary to get expert advice in the final solution of any particular feed-water problem, but it is possible for the average engineer to be well enough acquainted with the underlying principles to guide him in the general direction of the correct solution of his particular problem.

In general the theoretical air required to burn coal goes up in proportion to the heat value. For burning straight carbon every 1,270 B.t.u. requires one pound of theoretical air. The corresponding figure for the available hydrogen is about 1,800 B.t.u. The theoretical air required for the average coal can be closely approximated by dividing the heat value by 1,300.

Erecting Power Machinery Having Cast-Iron Bedplates

Proper Supporting of Machine Base — Preparing Top of Foundation — Handling Bedplate—Methods of Leveling and Aligning—Making Grout and Grouting Bedplate to Foundation—Assembling the Machine and Putting It in Operation

By N. L. REA
Construction Engineer, General Electric Company

MANY operating and erecting men apparently have a wrong impression of the strength and rigidity of machine bases. They expect the base to carry the load, and they give very little, if any, attention to setting it properly on the foundation. One often hears expressions something like this: "Oh, that machine has a heavy cast-iron base and we can set it on the floor anywhere."

The vast majority of machine bases, even those of cast iron, of deep sections, will deflect seriously if unevenly supported. They should, therefore, be considered simply as liners or templets to locate the parts of the machine properly and fasten them to the true foundation. Anyone doubting the foregoing should get a high-grade, accurate level and experiment a little on the next base he handles.

Causing Distortion in Bedplate

Uneven driving of the wedges or uneven spacing may distort the base badly. This distortion will be multiplied in the bearing pedestals and may cause serious difficulties. Possibly this point can best be illustrated by taking several typical cases through from the beginning.

Assume a machine delivered on the ground alongside a foundation. The foundation is of concrete and is fairly smooth on top. The first step is to lay out

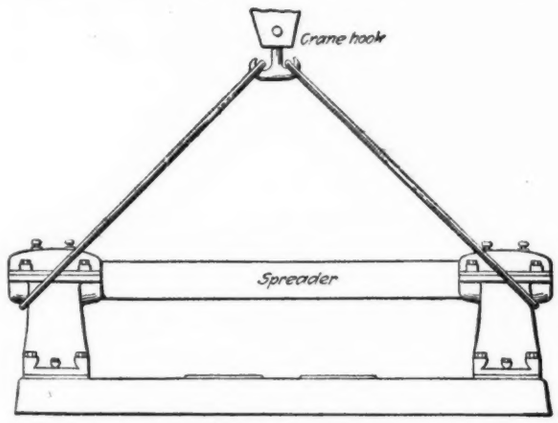
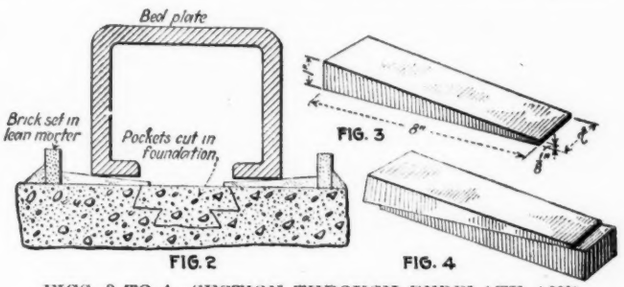


FIG. 1—METHOD OF LIFTING BEDPLATE

roughly the base outline on the foundation and then proceed to rough the foundation. The amount of roughing will depend on the character of the machine and the service it is intended for.

It is obvious that a self-contained unit, such as a frequency changer, rotary converter or motor generator, does not need as strong a bond to the foundation as a machine delivering or receiving power by belt or direct connection to a shaft. Foundation bolts are unnecessary for the motor generator, frequency changer and converter and may or may not be furnished for the motor or generator.

For the self-contained machines enough should be taken off the foundation to give at least an inch grout-



FIGS. 2 TO 4—SECTION THROUGH BEDPLATE AND LEVELING WEDGES

ing space under the bottom flanges of the base. The rougher the surface is left the better, and it is a good idea to cut under the edges and dig a few pockets to give a good bond between the foundation and the grout. Fig. 2 shows a typical cross-section of this roughing.

The top of the foundation should then be cleaned carefully, using special care to remove all dust and small particles from the pockets. A stiff brush or compressed air, under low pressure, is good for this work. The air should not be used if there is any chance of the dust's being objectionable.

Lifting Bedplate With Crane

In placing the base on its foundation, do not lift it with slings under the ends of the bearing pedestals unless a heavy spreader is used between them, as in Fig. 1. Otherwise the base or pedestals may be badly distorted or broken.

The number and size of the wedges will, of course, depend somewhat on the size of the machine. They can be ordered from the "village blacksmith" if only a few are required. On large jobs it will be considerably cheaper to have them made of cast iron in a local foundry. For the average job a wedge made from 1x2-in. bar-iron stock, as in Fig. 3, will fill the bill. They can be used singly or in pairs as in Fig. 4. The wedges must be closely spaced and evenly driven to prevent distortion.

The base should be set level. On two-bearing bases it is satisfactory to use a level on the spots machined for the feet of the magnet or stator frames. On three-

bearing sets a tight wire should be stretched through the bearing pedestals and the base aligned with reference to this wire. When it comes to tight lining, every man has his pet idea and far be it from me to attempt to dictate. However, one method may be of some assistance. The sag chart given herewith has been worked out for steel piano wire 0.166 in. in diameter, loaded with a weight of 30 lb. As an example in the use of the sag chart, take the case where the pulleys over which the wire run are 20 ft. apart, as shown in Fig. 5. The wire at the center 10 ft. from the supports will sag 16 thousandths of an inch; that is, if the wire at the ends is 4 ft. from the bedplate, in the center it will be 4 ft. less 0.016 in., or 3 ft. 11.984 in., as indicated in the figure, when the bedplate is level. In using the chart, locate in the top horizontal column the distance between supports, in this case 20 ft. Then the sag is found by finding in the vertical right-hand column the desired distance in feet from the supports, which, say, is 10; then run across to the correct distance between supports column and find the correct value of sag, or in this case 16 thousandths of an inch. At one foot from the support the sag is 2.5 thousandths and at 5 ft. it is 11 thousandths.

SAG IN THOUSANDTHS OF AN INCH FOR STEEL PIANO WIRE 0.166 IN. DIAMETER LOADED WITH A 30-LB. WEIGHT

Distance From Supports In Ft.	Distance Between Supports in Feet																			
	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
1	0.5	1	1.5	2	2.5	3	3	3	3.5	3.5	3.5	3.5	4	4	4	4.5	5	5	5	5.5
2	1	2	3	4	5	5.5	6	6	6.5	7	7	7.5	8	8	8.5	9	9.5	9.5	10	11
3	1.5	3	4.5	5.5	7	8	8.5	9	9.5	10	10.5	11	11.5	12	12	13	13.5	14	15	16
4	1.5	4	5.5	7	9	10	11	11.5	12	13	13.5	14	15	15.5	16	17	18	19	20	21
5	1.5	4.5	6.5	8.5	11	12	13	14	15	15.5	16.5	17	18	19	20	21	22	23	24.5	25.5
6	2	5	7.5	10	12.5	14	15.5	16.5	17.5	18.5	19	20	21	22	23.5	24.5	26	27	28.5	30
7	...	5.5	8.5	11	14	15.5	17.5	19.5	20	21	22	23	24	25.5	26.5	28	29.5	31	32.5	33.5
8	...	...	9	12	15	17	19	20.5	22	23.5	25	26	27	28.5	30	31.5	33	34.5	36	37.5
9	...	...	...	13	16	18.5	20.5	22.5	24	26	27	28.5	30	31.5	33	34.5	36	38	39.5	41
10	...	...	...	...	16	19.5	21.5	24	26	28	29.5	31	33	34	36	37	39.5	41	43	44
11	...	...	...	...	...	20	22	25.5	27.5	30	31.5	33.5	35	37	39	40.5	42	44	46	47.5
12	...	...	...	...	...	...	23.5	26.5	29	31.5	33.5	36.5	37.5	39.5	41.5	43	45	47	49	50.5
13	...	...	...	...	...	...	...	27	30	33	35	37.5	39.5	42	44	46	47.5	50	51.5	53
13	...	...	...	...	...	...	...	...	31	34	36.5	39	41.5	44	46	48	50	52	54	55.5
15	...	...	...	...	...	...	...	...	...	34.5	37.5	40	43	45.5	48	50	52	54	56	57.5
16	...	...	...	...	...	...	...	...	...	...	38	41	44	47	49.5	52	54	56	58	60
17	...	...	...	...	...	...	...	...	...	...	...	42	45	48	51	53.5	56	58	59.5	61.5
18	...	...	...	...	...	...	...	...	...	...	...	...	45.5	49	52	55	57.5	59.5	61	63.5
19	...	...	...	...	...	...	...	...	...	...	...	...	...	49	52.5	55.5	58.5	61	62.5	65
21	...	...	...	...	...	...	...	...	...	...	...	...	...	...	52.5	56	59.5	62	64	66.5
21	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	56	60	63	65	67.5
22	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	60	63	66	69
23	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	63.5	66.5	69.5
24	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	67	70
25	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	70.5

The values given in the chart are interpolated from a curve and corrected to the nearest 0.0005 in. It is customary to run this wire over grooved pulleys 3 in.

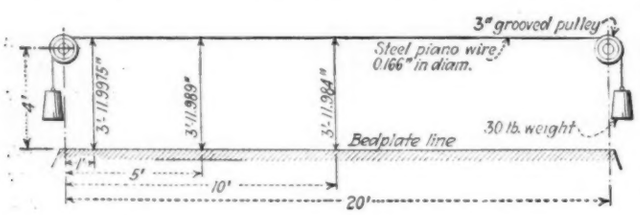


FIG. 5—SHOWS USE OF SAG TABLE

in diameter, mounted on brackets which, in turn, are clamped to the outer ends of the end bearing pedestals. These wheels and brackets may be anything from a plain wheel or curved segment on a piece of strap iron, to elaborate devices to permit of vertical and horizontal adjustments of the wheel in the supporting bar.

In any case the bar supporting the wire is fastened to the outer end of the outside bearing housings by C-clamps and adjusted so the wire centers in the housing. Individual preference comes in a lot in the methods of measuring and centering. Some prefer light measuring pins of steel or wood with fine needles set in

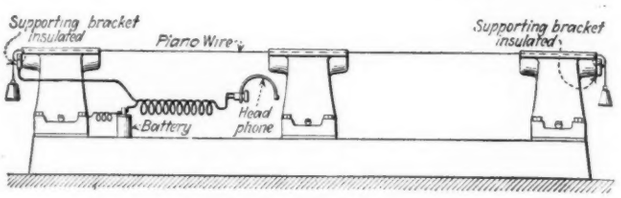


FIG. 6—ARRANGEMENT FOR TESTING ALIGNMENT WITH BATTERY AND HEAD PHONE

the ends and trust to their sense of touch or sight, or both, in determining contact.

Another method that works to advantage is to insulate the supporting brackets from the bearing pedestals by horn fiber or leather board. Then connect a battery and head phones between the tight line and the base, as in Fig. 6. The measuring can then be done with an inside micrometer and the "mikes" adjusted till the phone clicks. This cuts out the question of touch and can be used where the lighting is too poor to trust to sight. It can be worked quickly and gives accurate results. After the base has been properly leveled and aligned, it should be grouted and the grout allowed to set thoroughly before the assembly is started.

The amount of forms, or dams, necessary to hold the grout will depend on local conditions and the design of the base. Structural-steel bases or sole plates should be grouted full. Heavy cast-iron bases can be grouted an inch or two above the bottom of the lip inside the base. It may be necessary to move the machine some day, and grout makes hard digging. I have found that bricks laid with a lean mortar makes a cheap and satisfactory dam. They can be removed as soon as the grout has set, cleaned readily and put back into stock.

The foundation should be wet thoroughly just before grouting. The grout should, preferably, be made of one-half clean, sharp sand and one-half cement mixed thin enough to puddle thoroughly under the base, about

like thick porridge. If too thin it is longer in setting and harder to hold. The cement may also wash out of thin grout to some extent.

After the grout has set, the dams may be removed and any parts of the grout above the finished floor line troweled off. When the grout has hardened, which usually takes from three days to a week or ten days, depending on its depth and the age of the cement, assembly of the machine can proceed.

On large bases where a great amount of grout is required, old cement may be advisable. It sets slower and with less temperature rise than new cement, and the temperature rise, if excessive, might cause distortion of the base from expansion.

Pointers on Assembling the Machine

As this is intended as a general article, it is manifestly impossible to give detailed methods of assembly. In general, however, all polished parts should be cleaned of the protecting grease or "dope," the journal surfaces polished with crocus cloth, if necessary, and any burrs or rough spots smoothed off with a fine file or oilstone and coated with machine oil. The bearing housings, oil wells and linings should be carefully cleaned. If the machine has a circulating oil system, it should be flushed with kerosene or the oil circulated at an increased speed for several hours through the piping and the filter. It is advisable to make temporary connections to bypass all bearings while cleaning. Extreme care in installing the piping will reduce the necessity of cleaning materially. Some men even go so far as to insist that each length of pipe be blown out with steam or air after threading and reaming and before making up the joints. The pipe should be rapped with a light hammer or mallet while being blown out.

I have known of many cases where a little sand or metal chips have spoiled bearings and delayed starting for days. In one case that comes to mind, several new bearing linings and many hours' investigation on the part of operatives, machine designers and oil-company experts were required to find that a handful of cotton waste had been left in the bearing housing when cleaning. This was broken up into short pieces by the rings and oil and mixed thoroughly with the oil.

The assembly of a two-bearing set is comparatively simple. The base and shaft should be level and the air gaps adjusted evenly. If the set has three or more bearings, care must be taken to insure that all the bearings are in line.

Deflection of the foundation, bearing housings or of the base may change the initial line-up enough to cause bearing or shaft troubles. The constant bending of a shaft caused by misalignment may, in the course of time, cause fatigue and shaft breakage without any bearing trouble.

If the set has a solid flange coupling, back off the nuts half a turn, roll the revolving element one turn with the crane or jacks and watch the coupling. If the coupling faces separate, the shafts are out of line or the coupling faces are out of truth and the amount of separation will indicate the amount and direction of the fault. On large or heavy sets the deflection of the shafts may necessitate shimming the end bearing pedestals above the correct position to bring the coupling faces parallel.

If flexible couplings are used, the method of checking will be determined by its construction. In general, however, the impression prevails among many operators and erectors that flexible couplings are designed to take care of considerable errors in alignment, and some feel that the machines can be coupled "any old way" when flexible couplings are used. Misalignment will cause undue wear of flexible couplings or break shafts with solid couplings or cause the couplings to work on the shafts, even though the bearings do not show distress.

A good erector's motto should be, "Be careful, be accurate and do the best you know how." Do the best work possible and not just good enough to get by.

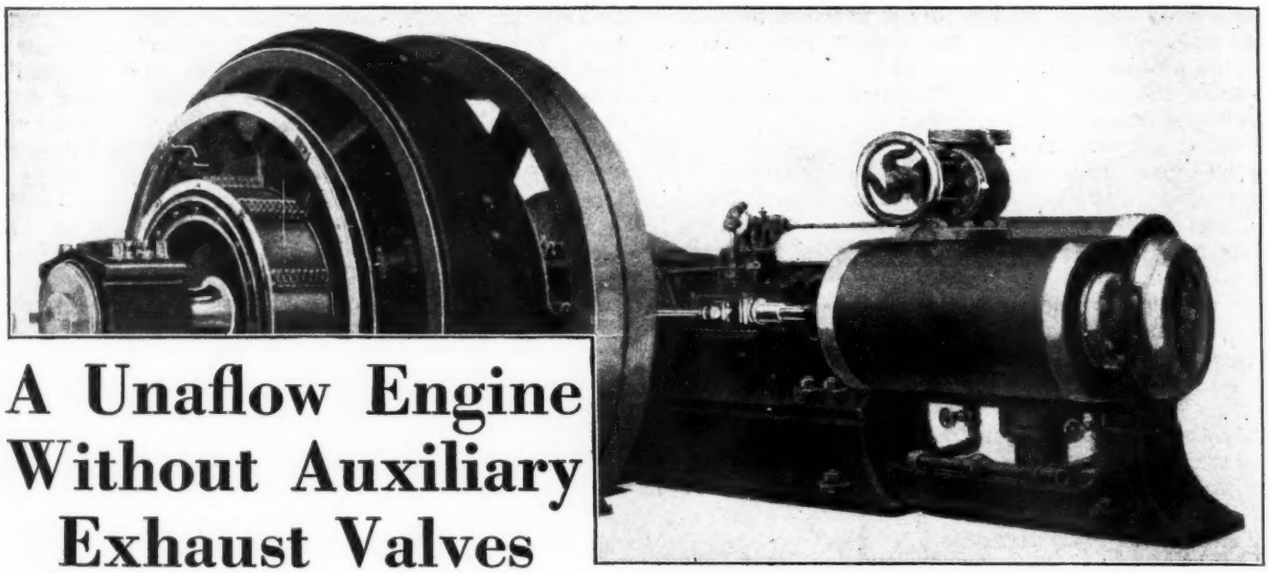
Oil Leaks May Be Expensive

If a generator winding becomes oil soaked, damage is the ultimate result, and one instance of a generator breakdown due to this cause will be related. After absorbing lubricating oil for several years, the winding of a large waterwheel-driven generator failed and started a serious fire, which could not be quickly extinguished because of the fanning action of the rotor. Brakes were not used on this unit, hence the rotor revolved for a considerable period after the turbine gates were closed. After emptying all the carbon-tetrachloride extinguishers available, acid extinguishers were used, and a large amount of liquid from these was applied to the winding before the fire was put out. Since the need for this generator was urgent, an attempt was made to use some of the old armature coils, but most of them were so affected by the acid extinguisher liquid as to make their use unsafe.

This burn-out indicated that the winding should have been kept free of oil, that brakes should have been provided for quickly bringing the rotor to a standstill, and that acid fire extinguishers should never be used to combat a fire of this nature. In fact, it seems that those extinguishers using a liquid harmful to insulating material should be excluded from locations near electrical equipment liable to damage from its use. Also, a number of carbon-tetrachloride extinguishers should be provided, with provision for quickly refilling them, in generating stations.

Careful attention is not always directed to the detection of oil leaks, as can be understood from the following unusual case: In a certain station the monthly consumption of lubricating oil for a long time averaged 500 gal., strangely arousing little suspicion of a large preventable oil leak. It was eventually discovered, more by accident than by intention, that a drain pipe from a turbine guide bearing was obstructed by waste and that oil from this bearing drained into the turbine, thence to the tailrace. Cleaning the drain pipe resulted in a saving of over 200 gal. of oil a month. While this is an unusual case, it may serve to emphasize the importance of keeping accurate records of oil consumption, so that any change may be noted and investigated, also that it is well occasionally to check the oil discharge from individual bearings and, where possible, to learn how the oil used compares with that consumed in other generating stations.

After difficulties have arisen and have been remedied, it is obviously an easy matter to point out what should or could have been done to overcome them more quickly or avoid them entirely. But progress depends largely on the study devoted to past occurrences, and it is only by heeding operating troubles coming to one's attention that benefit may be derived from the difficulties experienced in other stations.



A Unaflow Engine Without Auxiliary Exhaust Valves

A LARGE portion, if not a majority, of unaflow engines, are in plants where non-condensing operation is necessary. The small clearance employed on condensing unaflows is of course prohibited on engines working against a back pressure, for in the latter case a small clearance would cause the compression pressure to rise higher than the boiler pressure. As has been outlined in the unaflow engine discussions that have appeared in *Power*, this is avoided by one of two means. The first and older arrangement is the addition of extra clearance spaces in the cylinder head communicating with the cylinder clearance by a valve. The opening of this valve increases the clearance volume. The second method, now largely adopted, consists of auxiliary exhaust valves which allow part of the steam trapped in the cylinder by the piston to pass out the auxiliary valve when operating non-condensing. Both of these methods involve heat losses. In order to obtain maximum economy, unaflow clearances must be kept low; consequently, the use of auxiliary clearance spaces is not of advantage, especially when located in the cylinder heads. The exhaust steam passing out the auxiliary valves absorbs considerable heat from the cylinder head, which means an unrecoverable loss.

Dual Clearance

A novel means of avoiding the objectional features just outlined is incorporated in the design of the Harrisburg dual clearance unaflow. This engine is provided with central exhaust ports as in the Stumpf unaflow, but in place of the customary steam valve for each end of the cylinder, a single piston valve is used, this being the same as used on high-speed engines.

Fig. 2 shows four positions of the piston and valve. In Fig. 2 *A* the piston valve is shown uncovering the head-end steam port, admitting steam into this end of the cylinder. At *B* the valve is moving to the right, and at *C* the valve is at the point of head-end cutoff. The steam in the head end expands behind the piston as in the ordinary engine. Turning to Fig. 2 *B*, it will be noticed that the crank-end port is uncovered by the valve and not only is the crank end of the cylinder filled with exhaust steam, but so is the clearance pipe *E*. The pipe and passages at each end have a volume of from 50 to 60 per cent of the cylinder volume. The movement of the piston toward the right then comprises this total volume of exhaust steam. The result is that the compression at any point in the stroke is less than it would be without the dual clearance pipe. At *D*, about 20 per cent from the end of the stroke, the valve has moved to the right until it covers the crank-end port, cutting off communication between the cylinder and the clearance pipe. Compression in the crank end thus proceeds until the cylinder steam is compressed into the cylinder clearance space. At the instant the valve covers the crank-end port, it uncovers the head-end port and the steam in the clearance pipe *E* then flows into the head end, and the expansion line, since there is a larger volume of steam, will be above that for the cylinder feed only. When the piston uncovers the central exhaust ports, the steam flows out of the cylinder. On the next stroke the events are repeated in the crank end of the cylinder.

It must be noted that this arrangement provides an extra clearance volume for part of the stroke and that any heat picked up by this clearance steam from the hot cylinder head is returned to the opposite end. There is,

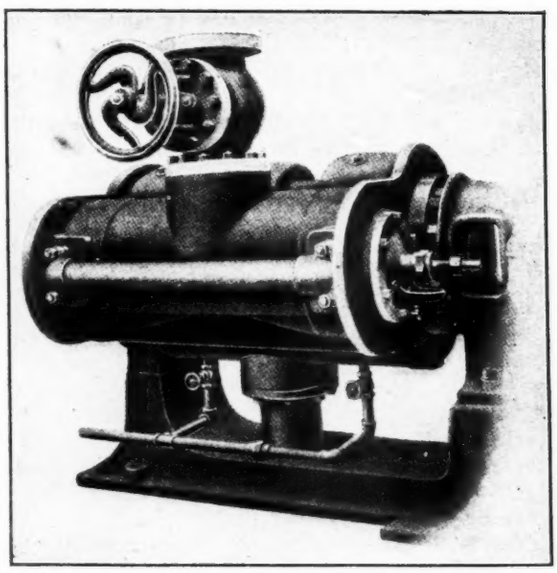


FIG. 1—DUAL CLEARANCE PIPE

of course, a slight heat loss due to the small pressure drop through the pipe *E*.

In Fig. 3 is shown the types of valves used in this engine; the large units are filled with the double-ported valve at *B*.

In case an engine is to run condensing, the valve ends are spread apart so that the dual clearance pipe is not

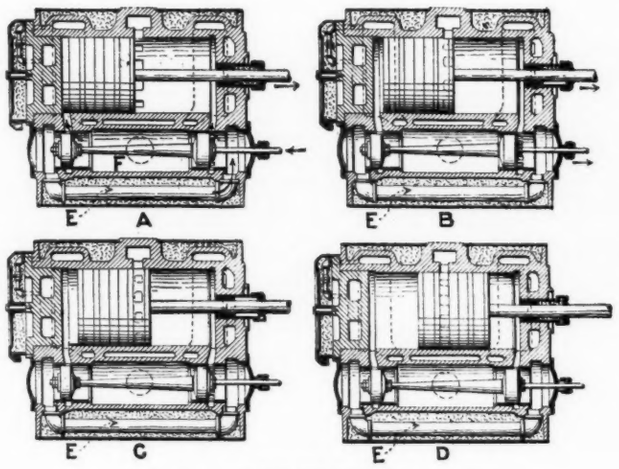


FIG. 2—ACTION OF PISTON VALVE

uncovered by the valve. To change to non-condensing operation requires the readjustment of the valve, a matter of one to two hours' shutdown.

The method of setting the valve is shown in Fig. 4. The first step is to locate the crank dead-center points by any of the usual methods. The eccentric rod is next adjusted in length until the valve block to which this eccentric rod is pinned, moves equal distances from the center of the valve block guides when the eccentric is moved to the two extremes of its throw.

The valve is now disconnected from the block and drawn out of the steam chest. Templets of the valve and the valve-bushing ports are made. The distance of each port edge from the face *o* of the steam chest is measured by a wooden rod. This rod, as shown in

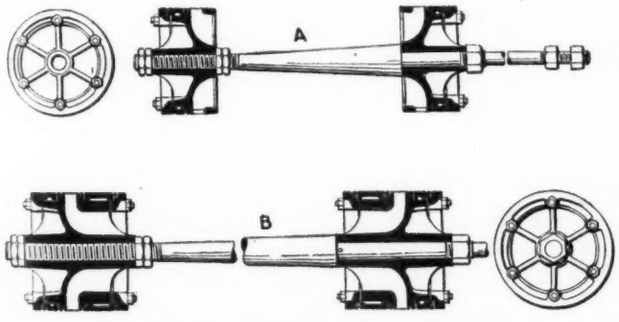


FIG. 3—TYPE OF VALVE USED

Fig. 4, has two small tin or sheet-iron lugs nailed to it. By allowing the lug to drop into the steam ports, the distance from *O* is quickly and accurately transferred to the templets. The port dimensions, as well as those of the valve, are marked off from the point *O*. The valve templet is then shifted until it covers both the head-end and crank-end steam ports by equal amounts; that is, there are equal laps. The distance from *O* to the valve templet is measured and replacing the valve in the steam chest end with the eccentric in midposition or the valve slide block at the center of its travel, the valve rod is adjusted until the end of the valve is the same distance from the face of the steam chest as is the valve templet with equal laps. The governor weight should be placed in the normal position for full-load conditions. The engine should be set on head and crank dead centers and the positions of the valve measured and transferred to the templet. It will then be determined if the two leads are equal, and if the setting of the valve has been done properly the leads should be equal.

The spring should be removed and the weight arms shifted to their extreme outward or no-load position. The travel of the valve should be assured and referred to the templet to determine if the valve uncovers the ports or not. If the port is uncovered, it will be necessary to remove the valve, screw the ends together until the amount of lap is sufficient to keep the valve closed when the governor is at its out position.

Indicator diagrams should be taken, and if necessary the valve should be changed in its position to suit requirements. It is important that the compression be kept below the initial pressure by from five to ten pounds. If the indicator diagram shows the conditions to be different, it will be necessary to remove the

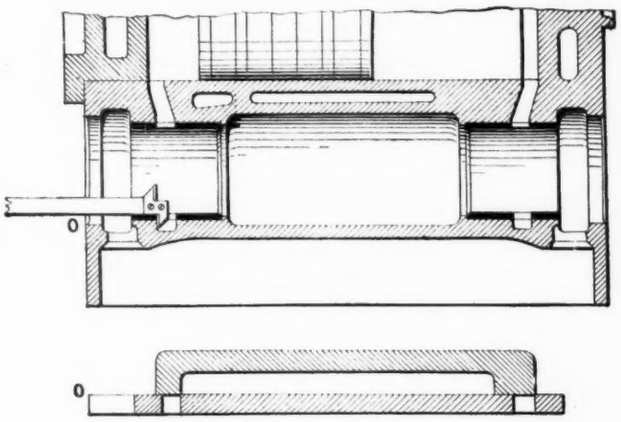


FIG. 4—METHOD OF SETTING VALVE

amount required, turning off in a lathe or filing the exhaust edge.

If it is desired to increase or decrease lead, this can be done by the nuts on the valve stem, where the valve heads are locked. To increase lead lengthen the distance between the valve heads, and shorten this distance to decrease lead.

[This is the final of a series of discussions on the several unaflow engines built in this country including methods of setting the valves. Others appeared in *Power*, Oct. 17, Oct. 24, Nov. 7, Nov. 14, Nov. 21 Nov. 28, Dec. 5, Dec. 12 and Dec. 19.—Editor.]

The senses of sight and smell are all that the refrigerating engineer needs to detect leaks in joints exposed to the air, although sulphur sticks, hydrochloric-acid atomizers and litmus papers are used to advantage. Where joints are directly in contact with brine or water a different method must be used, since the water will absorb much ammonia. To detect leaks of this character, the use of litmus paper or, preferably, Nessler's solution is necessary.

Cutting Fuel Costs

BY GEORGE F. SWETNAM

In former days, when coal could be bought for $3 a ton or less, it was possible for the engineer to wink at fuel expense and give his time to other things. Now, however, anything that is concerned with lowering fuel bills is pertinent.

Theoretically, it might be possible to regulate the draft of a furnace so that the amount of air admitted would be exactly that needed for complete combustion;

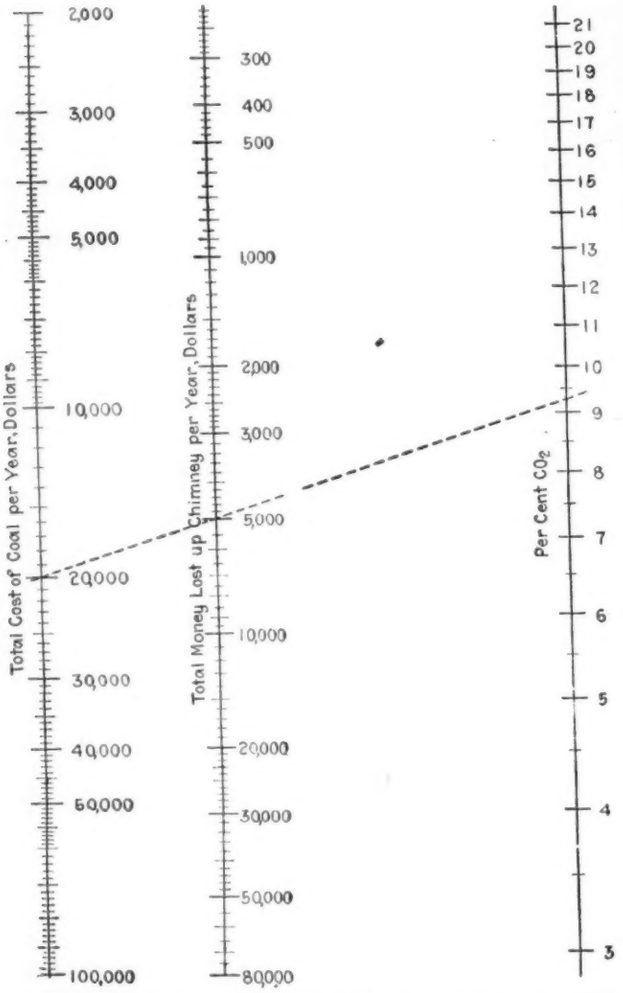


CHART SHOWING CHIMNEY LOSSES COMPUTED FROM TOTAL COST OF COAL AND CO_2 READING BASED ON HIGH-CARBON COALS AND 600 DEG. STACK TEMP.

practically, it is far from it. Even when the utmost care is employed, much more air than is necessary is admitted. When guesswork is used, conditions are usually still worse.

The excess air is heated and carried out through the stack with the products of combustion, this stack loss in the average boiler plant being about 35 per cent of the heat generated and in many plants exceeding 50 per cent of the total fuel consumed.

One of the best ways of reducing these losses is to install some type of CO_2 recorder. Some plants are so small that the cost of a recorder would be prohibitive; for these the best thing is common sense. A little experimenting will show at what approximate draft, pressure can be kept up with the least coal. Of course it will be necessary to change the draft with changing conditions.

Without a recorder it is impossible to calculate the exact waste at any plant, but when it is considered that CO_2 is often as low as 7 per cent, the chart developed by the Uehling Instrument Co. and shown herewith will show how enormous the loss is likely to be.

To compute the loss, lay a straight-edge on the annual amount you spend for fuel, which is in the left-hand column, and on the probable percentage of CO_2, in the right-hand column. The point at which the straight-edge crosses the center line is the annual waste of fuel in dollars. This scale is approximately correct for high-carbon fuels and a stack temperature of 600 deg. F.

Thus, if your fuel bill was $20,000 a year and your CO_2 was 9.3 per cent, as indicated by the line on the chart, the annual waste would amount to $5,000, or about one-fourth the total expenditure. Your CO_2 may be as low as 6 per cent, in which case the loss would be $7,500. By installing an indicator it should be possible to get a CO_2 per cent as high as twelve, making the loss only one-fifth. Needless to say, the thousand dollars saved the first year would be worth while.

Now as to the instrument that effects the savings. Some types are built in sections, so that the same instrument may be used to record for a number of boilers, but with a separate recording chart and indicator for each boiler. Other types allow more recorders to be attached to the machine if new boilers are installed. The recording charts and the recorders proper may be placed anywhere in the plant, though usually they are kept in the chief's office. By placing an indicator on the front of the boiler the fireman can tell at a glance if there is too much air being admitted and can change conditions. If he fails to do so, the recording chart in the office will show it all.

With such a guide the fireman is encouraged to do his best work. The indicator records each time that the furnace door was opened and how long it remained open. If there are cracks in the boiler setting, the extreme difficulty of getting the CO_2 to anything like a proper figure will show it.

The principle upon which the CO_2 recorder works is quite simple. In some machines the stack gases are supplied at a low pressure by means of a pump. They are passed through a substance which absorbs the CO_2. This lowers the pressure, and by an automatic comparison of the difference in pressure on the two sides of the absorber the per cent CO_2 is calculated.

A filter should be placed in the system to remove solid particles from the gas and so prevent clogging of the machine. The absorbent material is solid in some makes, while in others it is a liquid. In either type it must be renewed at frequent intervals.

Some groups of substances combine easily, some with difficulty, and many not at all. When certain combinations occur, heat is given off, while others absorb heat. In the first case the temperature rises and in the second it falls. As a rule, two or more elements will combine only in certain proportions. For example, when a mixture of oxygen and hydrogen (in the proper proportions) reaches a certain temperature, there is a flash or explosion, and each atom of oxygen (O) combines with two atoms of hydrogen (H) to form one molecule of water (H_2O).

EDITORIALS

Demand Must Precede Extensive Development

PROBABLY no type of electrical machinery is representative of greater improvement in its characteristics than the synchronous motor. As first applied, the machine was anything but a satisfactory piece of equipment either as to its starting torque or as to its performance after being connected to the system. About the only redeeming feature it had was the ability to correct the power factor of the system on which it operated. If it had not been for this quality and the fact that the induction motor is inherently a low power-factor machine, synchronous-motor development would probably have been practically abandoned.

At first, progress toward a satisfactory machine was slow, chiefly because of the lack of an incentive for the manufacturers to develop such equipment. The central-station companies were little interested in the power factor of their loads as long as they got it on their systems. Competition was too keen between these plants and the industrial power plant for the former to quibble much over the character of the load so long as they got it. In a large percentage of the industries direct current was generated, so that power factor did not enter into the power problem. In those plants where alternating-current was generated, labor and coal were so cheap as to make power cost of secondary consideration in most manufacturing establishments. Consequently, the motor that was the cheapest to install and maintain was what interested the average manufacturer. But this has all changed; alternating current is now used in a large proportion of the important industrial plants. The cost of labor and coal has increased to where power is becoming of considerable importance in production costs. The central stations have for a number of years found their systems loaded up with induction motors operating at low power factor and have been giving serious consideration to how best to relieve this situation. Many of these companies now have penalty clauses in their rates, which they enforce when the average power factor for the month drops below a specified value, while other companies penalize for low power factors and pay a bonus for maintaining a power factor above a given value. These charges frequently make the installation of synchronous motors for power loads and power-factor correction a profitable investment.

This changed condition has created a demand for satisfactory synchronous motors for all kinds of drives. To meet this requirement, the electrical manufacturers for the last few years have been carrying on extensive investigation to produce satisfactory motors of this type. Many of the earlier synchronous motors were started by some source of mechanical power, brought up to speed and synchronized with the power system in the same way as an alternator, after which the load was applied. If conditions were stable in the power system and the motor was driving a fairly constant load, it might be stable in its operation, otherwise serious trouble due to hunting was frequently experienced. Recently, there were put into service two five-hundred horsepower synchronous motors operating at eighty revolutions a minute, driving ammonia compressors, which are started automatically. So far as getting the motor into step, this class of drive represents a most difficult one, on account of the inertia of the moving parts and having to bypass the gas during the starting period. Although this is not the first time that synchronous motors have been started automatically, it is probably the most difficult and shows what may be expected when there is a demand for such equipment. There is going on at the present time much development work, that promises further important improvements in the characteristics of this type of motor which will probably make it available for applications now considered outside its field.

Guarantees and Acceptance Tests

IN DRAWING up the contract for a boiler, turbine, pump, condenser, generator or other piece of power-plant apparatus, a guarantee is generally exacted as to its performance under a set of specified conditions.

A test to determine compliance or non-compliance with the guarantee—a so-called acceptance test—must be made by highly trained, impartial engineers, unrelated to either of the parties at interest. It is expensive to make, often involves interference with service, and if the performance appears, with such checking up as the purchaser can make upon it in regular operation, to be fairly satisfactory, the acceptance test is often waived.

The guarantee clause in the contract has served its purpose in protecting the purchaser against a serious shortcoming in the performance of whatever he has bought; and he is so well satisfied that it is doing about as well as was expected of it that he does not consider it worth while to determine just how much better or just how little worse it is doing.

The regrettable feature of this situation is that it invites ridiculous guarantees from unscrupulous bidders against which honest engineering has no chance. We are reminded of a manufacturer of power-plant apparatus who, being asked in open meeting how he could guarantee performances which were palpably impossible, replied frankly that not more than one in a hundred of his installations was tested and that he could afford to take out one in a hundred.

When a test is made, however, it is generally found that it is impossible to maintain the exact conditions of the contract. If the load is exactly controllable, the conditions of pressure, temperature, vacuum, quality, etc., can be brought and kept to those specified by nothing short of a miracle. The testing engineer may be able to find out what the apparatus under review can do under the conditions furnished, but can only guess at what it might do under the conditions specified.

And so—and this was the thought with which we "took our pen in hand"—the contract guarantee should be broad and flexible enough to be adjustable to attain-

able conditions. There should be an allowable range of pressure or speed or temperature, and some agreement as to adjustment of the guaranteed results to the actual test conditions. If this has not been taken care of in the contract, no important test should be undertaken without a definite agreement between the parties to the issue as to allowance to be made for departures in the test conditions from those upon which the guarantee is based.

Rapid Progress in Feed-Water Treatment

"A REVIEW of Feed-Water Treatment" on page 1018 of this issue brings to a close the series of articles which *Power* has been running on this important subject. The ending of this series does not mean that the "last word" has been said on feed-water treatment. These articles are more in the nature of a "first word" and will serve their purpose if they give the reader a broad foundation upon which to build a more detailed knowledge of the particular type of apparatus with which he is directly concerned.

The whole question of feed-water treatment has acquired a new importance in recent years. In the old days, when boilers were rarely operated above rating and the average operating engineer hardly knew what efficiency meant, the scale problem was generally handled by hit-or-miss chemical dosing of the boiler or by hacking out the deposit after it became so thick that the boiler would not keep up steam.

This kind of operation may have been good enough for the horse-car age, but it does not meet the needs of modern plants where boilers must operate almost continuously at high ratings. The modern viewpoint on the scale question may be summed up in the following sentence: "If any scale gets in the boiler clean it out, but concentrate your attention upon keeping the scale from getting into the boiler." Whether chemical or zeolite treatment or distillation should be used depends upon the conditions at the particular plant.

Along with scale, corrosion is coming in for its share of attention. One need only glance at any junk dealer's scrap pile to get an inkling of the nation's tremendous annual corrosion loss. A large part of this waste is in connection with the iron and steel used in piping, boilers and other equipment constantly exposed to water saturated with oxygen and other impurities. Similar losses used to be common in the case of structural-steel work exposed to the weather, but this is now effectively prevented by the use of special protective paints.

Although similar methods of protecting the water-covered surfaces of piping, boilers, etc., may some day be perfected, the only generally effective method now known of preventing such corrosion is to deaërate the water. With feed temperatures around 212 degrees F. this is accomplished by the ordinary open heater if properly designed and well vented. At the lower feed temperatures found in some of the more modern plants, special equipment is required. That there is a real demand for apparatus of this sort is shown by the fact that several new types of deaërators have recently been placed on the market.

This all goes to show that there is a whole lot to the subject of feed-water treatment, and that engineers must pay particular attention to it if they expect to keep up with the procession.

New York's Water Power

JUST what the incoming Democratic administration in New York State will do in the matter of hydro-electric development is now a matter of great interest. Will it temporize and investigate, appropriating a few million dollars for some spectacular development? Will it select the upper Hudson, the Niagara or the St. Lawrence River and appropriate a substantial sum toward the completion in five years of a 500,000- to 1,000,000-horsepower development?

Among other things the platform upon which the Democratic party came into power in November provides for: "Development and distribution by the state of hydro-electric power for the benefit of all the people in order to bring about cheaper light and power. Hydro-electric power can and should be developed as a state-owned public utility in every section of the commonwealth." This language is somewhat ambiguous, unless the state would purchase water power where it does not already own it. The principal water powers within the state are confined to the following:

1. The Niagara River, where the amount of water which may be diverted for power purposes is limited by international treaty requirements, although negotiations are under way for an increase of the allotment of water for these purposes. No state development can take place here until the outcome of the present test suit between New York State and the Federal Government, on the constitutionality of the water-power act, has been determined. Hearing has been set for January 2.

2. The St. Lawrence River, where there is available approximately 700,000 horsepower on the American side.

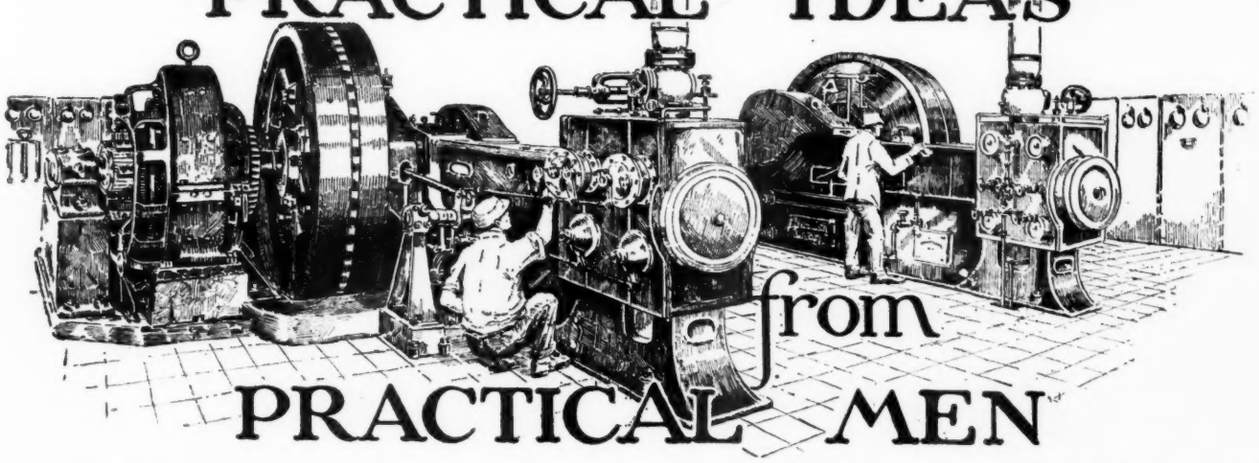
3. The Hudson River watershed, waters of the upper Hudson River and its tributary streams, where 500,000 horsepower might be developed.

4. Surplus waters of the barge canal. Statements in the press to the effect that a million or more horsepower are running to waste along the route of the barge canal are somewhat extravagant. The maximum possible development is 40 to 50,000 horsepower.

Therefore the incoming administration, in order to fulfill its campaign pledges, faces the inauguration of a program calling for the ultimate expenditure of $150,000,000 or more, which would be sufficient to put 1,000,000 horsepower on the transmission lines if power were developed at the most favorable points. If the bulk of this power were transmitted the three hundred miles from the St. Lawrence to Greater New York, over state-owned transmission lines, the cost would be $30,000,000 more. Any extensive development of the waters of the upper Hudson calls for the adoption of some definite program for water storage.

While in some quarters there seems to be a call for the repeal of the Robinson water power law, as a part of the program for state development of hydro-electric resources, general opinion holds that this law will be allowed to remain on the statute books as a supplement to the state's activities. The Robinson law, passed at the 1921 session of the New York State Legislature and amended and strengthened at the 1922 session, provides for the development of such water power as is subject to state control, by lease to privately financed corporations for a term of not to exceed fifty years, the lease being filled with stipulations as to purchase of the project by the state, limitation of profits and regulation of service and charges by the Public Service Commission.

PRACTICAL IDEAS from PRACTICAL MEN



Why Not Use Air Instead of Steam in Cylinder Jackets?

The use of hot air in the jackets of engine cylinders looks to me like an attractive field for experiment.

Where preheaters are used, a large volume of heat, at a low temperature head, is recovered at slight expense. The usual practice is to return this heat to the firebox in the form of hot air.

It is my opinion that this air could be raised to any suitable temperature, say from 500 to 800 deg. F., and circulated in the cylinder jacket and then returned to the firebox to support combustion. I should like to see some discussion in *Power* on this subject. J. BAGRIE.

Tyrone, New Mex.

Operating Troubles and Prevention

So many controllable difficulties arise in connection with routine operation of a power plant that one might feel that a constant endeavor would be made to insure their prevention, but such, unfortunately, is not always the case, as may be inferred from a relation of actual occurrences that can be classified as operating troubles.

In a certain station where the dam formed the upstream building wall, considerable water oozed through the concrete, but no inspections were made to determine if moisture appeared in any of the numerous conduits in the wall. It was eventually discovered that a contactor which controlled a large oil switch closing solenoid would occasionally close without apparent cause and remain closed until knocked open with a broom handle. As the contactor was located near the switchboard, the operators could hear it close, and the contactor was opened several times before the solenoid, which was designed for intermittent duty, was damaged. At the time when damage did result, the operator failed to hear the contactor close, and by the time that the odor of burning insulation attracted his attention, there was little need of reaching for the broom handle.

It was then decided to examine the control wiring, and it was found that at times a sufficiently high voltage would appear across the contactor coil to attract its armature, and due to the magnetic circuit then being closed, the rather low voltage indicated by the voltmeter would hold the contactor closed until knocked open. The voltage across the contactor coil was subject to considerable fluctuation, this being characteristic of a circuit completed through moist insulating material. After this condition was disclosed, it was decided to replace the control wiring, but the cable of which it formed a part had become so firmly attached to the interior of the conduit that only a portion of it could be withdrawn, and this part of the cable appeared to have been immersed in water for weeks. It was an easy matter to pull new control cable into a spare dry conduit, but considerable time was required to obtain a new solenoid coil.

Had careful attention been paid to the indications of the control-bus ground lamps, evidence of moisture could probably have been detected before the insulation failed to such an extent as to cause the contactor to close, or when the contactor did close, immediate attention to the control wiring would have prevented the destruction of an expensive coil. RALPH BROWN.

Belden, Calif.

Leather Replaces Babbitt in an Emergency

The following account of a burned-out bearing and how it was kept in service temporarily, may be of interest to readers of *Power*.

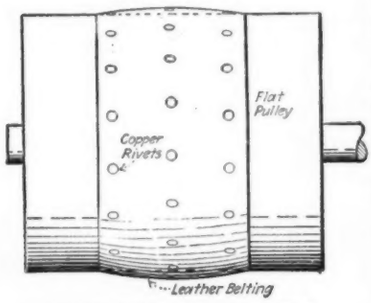
In our plant there is only one crusher used for icing refrigerator cars, and there is no other means of doing this when this crusher is out of order. One day recently I was notified by the operator of the crusher that it would not run, so I hastened to the icing dock, to determine the cause. The crusher roll was 30x36 in. and weighed about 400 lb. It was readily seen that the drum shaft had run dry and had wiped all the babbitt out of the bearing and was badly scored and grooved due to wearing down into the cast-iron box. This had lowered the drum so that it finally struck the decking below, preventing it from turning.

As several cars were waiting to be iced, it was impossible to do anything but a makeshift job. After loosening up the bearing caps, the drum was raised with a set of falls, and two thicknesses of heavy leather belting that had been well soaked in oil were slipped under the shaft. The shaft was then filed as smooth as possible, and when the machine was again started up it ran without trouble till the following Sunday, when we were able to dismantle the crusher, put in a new shaft and rebabbitt the bearings. H. M. TOOMBS.

Chicago, Ill.

A Simple Method of Crowning a Flat Pulley

A belt-driven generator in our plant was originally fitted with a flat-faced pulley, and the belt would frequently run over to one side when an increase of load was thrown on the generator. To overcome this, a crown was made on the pulley with leather lagging as illustrated in the cut. A piece of single-ply leather belting 8 in. wide was procured and shaved down thin on the edges, and punched for three rows of ½-in. rivets. The leather was then fitted around the center of the pulley and the rivet holes were marked and drilled in the rim. The pulley was then warmed with a gasoline torch and a coat of belt cement applied and the leather pressed on smoothly, care being taken to draw it straight and to fit the ends together evenly. The rivets were then put in and headed up and the cement allowed to set twenty-four hours. This machine has run over four years since the job was done, and the driving belt has run perfectly under all conditions.



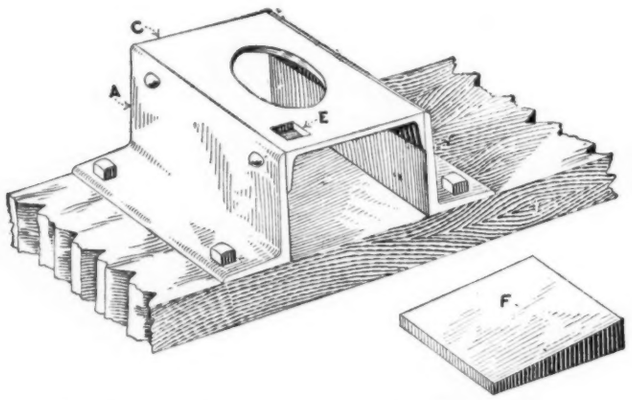
A PIECE OF LEATHER BELTING IS SHAVED DOWN AND APPLIED TO CENTER OF PULLEY

Camden, Me. M. M. BROWN.

A Practical Holder for Boiler-Tube Plates

We, like most everyone, have encountered considerable difficulty in trying to hold a water-tube boiler handhole plate in the ordinary vise for cleaning the threads of the studs and nuts.

To facilitate the holding of these plates and to accelerate the operation of cleaning the threads of the studs and nuts we devised the holder for the handhole plate and a tap as shown in the sketch.



HANDHOLE PLATE IS PLACED IN HOLDER AND SECURED BY THE WEDGE

The holder was made by riveting a piece of 2½x8-in. channel iron *C* 10 in. long between two pieces of 4x6-in. angle iron and bolting them to a plank as shown, an elliptical hole was cut in the channel for the handhole plate and the square hole *E* was made close to one corner to hold the tap for cleaning up the threads in the nuts.

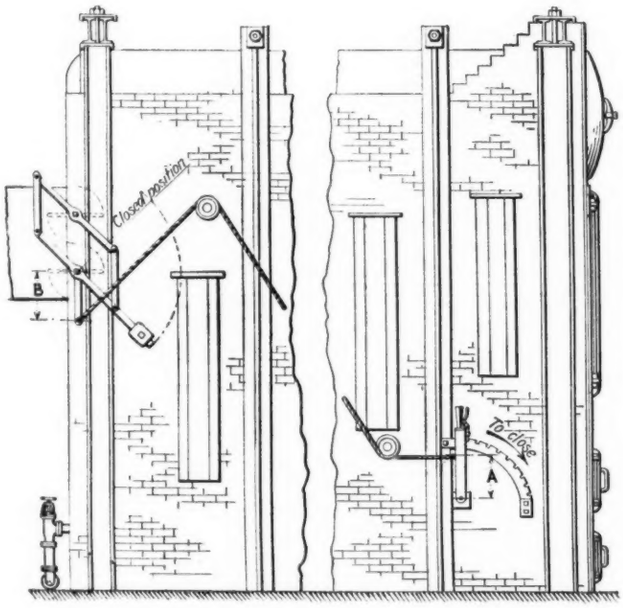
In using, the handhole plate is dropped (with the stud up) from the top or pushed up from the bottom through the hole and made fast by driving a wooden wedge *F* under the plate. The wedge bearing on the center of the handhole plate holds it tight.

The practicality of the device lies in its simplicity of construction and in the fact that, having secured clean threads on both nut and stud, when replacing the handhole plate the nut may be screwed down with the fingers, thus facilitating the work.

East Bridgewater, Mass. F. B. WHEATON.

Control for Damper Placed in Convenient Location

As the close regulation of the breeching damper of a boiler is necessary if good operating results are to be obtained, the lever or mechanism for operating this damper should, when possible, be placed at the front of the boiler so it will be unnecessary for the fireman to walk around to the rear, for where this is necessary the damper is usually thrown from full open to full close and vice versa, and poor operating conditions result.

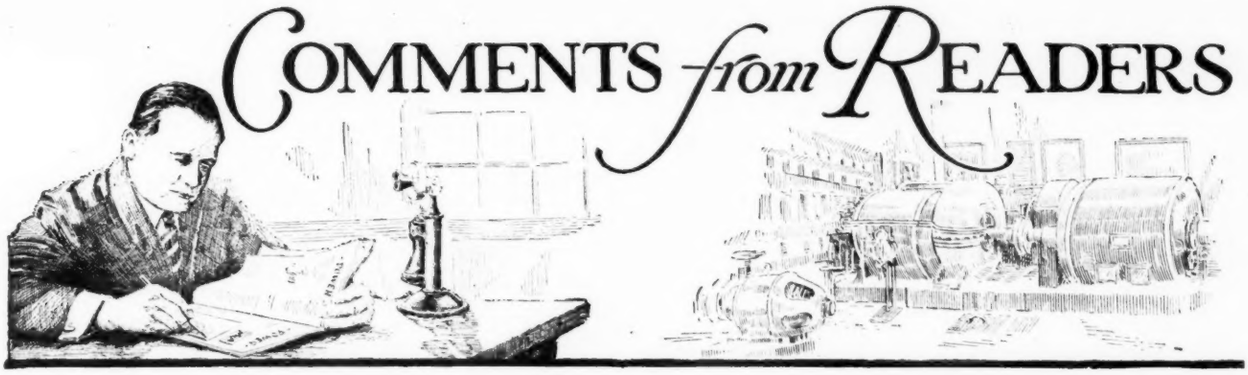


METHOD OF OPERATING DAMPER FROM BOILER FRONT

One method of operating a damper from the front of the boiler is shown in the cut, and with a few modifications it can be adapted to the different types of boilers.

The levers for the dampers can be made from ⅜x1½-in. bar iron. When drilling for the links, care must be taken to make the distance between centers the same. The dimension *B* must be equal to or less than the dimension *A* of the regulating lever. A quadrant or some form of stop can be used to hold the lever in the desired position. For connecting the damper arm and the regulating lever, a light chain or cable is satisfactory. The weight and the adjustment of the counterweight are best determined by experiment and should be sufficient to give positive opening of the damper.

Struthers, Ohio. J. V. EMERY.



Auxiliary Ports in Unaflow Engines

H. G. Mueller, in his discussion appearing in *Power*, Dec. 19, in reply to my criticism of Sept. 12, fails to clarify those points brought out in my discussion.

He lays stress upon the fact that Professor Nagel found that the cylinder-wall temperature at any point along the barrel was always above that of the steam at the pressure existing at this point. From this he deduces that moisture cannot exist on the walls. He apparently ignores the fact that there is a temperature drop between the iron wall and water film, likewise that this film is being constantly renewed by condensation of the steam. It is well known that moisture does not instantly evaporate from a hot surface.

However, the existence of moisture on the cylinder walls at the point of release, which moisture I stated was re-evaporated and passed out through the central ports, may be ignored, as in many respects it is not an essential point in the controversy. Consequently, it will be assumed here that the moisture that Mr. Mueller admits must exist, is not on the walls but is held in suspension in the steam.

The argument I advanced—that this moisture is re-evaporated and passes through the central exhaust—still holds true. That the cylinder walls are above the steam temperature affords part of the heat necessary for this evaporation. The remainder is supplied by the hot piston and a small amount from the steam itself. In passing through the hot exhaust ports, undoubtedly the moisture that is heretofore unevaporated is turned into steam.

Mr. Mueller's assumption that moisture will pass equally through the central port and the auxiliary exhaust is in contradiction to the basic claims of the unaflow-engine builders. It is generally claimed that by reason of the unidirectional flow of the steam the steam is not subject to turbulence. The quality of the cylinder contents progresses from dry at the head to wet at the exhaust belt, and this condition is one of the reasons why the steam-jacket loss is less than with the counterflow engine.

Quoting from Professor Stumpf, "The greater part of the moisture produced will be found close to the piston head with a progressive dryness and an increase in temperature toward the cylinder head. The moist steam, being close to the exhaust ports, will escape first when they are uncovered, while that portion which received heat from the head jacket is trapped by the returning piston."

Assuming that Professor Stumpf is correct in this statement—and it seems logical—then when the central ports are uncovered, the wet steam will escape, either as moisture or dry steam. The steam passing through the auxiliary ports will then be dry and in all probability often superheated, and cannot abstract any great amount of heat from the jacket. It will seem that the central ports must handle a greater percentage of the cylinder contents than Mr. Skinner's computation shows. There is a second reason for this statement. When the piston uncovers the ports, a high velocity of steam flow sets up, which serves to withdraw a greater volume of steam than calculated; it is even possible that the cylinder pressure is lowered below the expected pressure by this action. The unidirectional steam flow will also cause the water, by its momentum, to blow out the exhaust ports, leaving only dry steam.

As to the citation of the trouble Mr. Mueller had with corrosion in the early auxiliary valves, there is no reason to ascribe this to moisture coming from the cylinder. These auxiliary valve cases are quite exposed; and undoubtedly considerable heat is lost by radiation, and it is to be expected that part of the steam left in the auxiliary valve case and piping after the closure of the valve, will condense.

I cannot see where my conclusion as to the economy of a four-valve engine with superheated steam nullifies or contradicts my contentions as to the flow through the ports. I claimed and still hold that the percentage of the steam passing the central ports is greater than Mr. Skinner calculated. The fact that Mr. Skinner's values, when plotted, fall along a smooth curve while mine fail to do so, is no argument as to the truth or inaccuracy of either method of computation. Mr. Mueller has already conceded that this curve does not take into account the moisture that must pass out of the cylinder. Consequently, this curve is confessedly wrong and there is no advantage in discussing it.

The location of the auxiliary exhaust valve at the end of the cylinder has a distinct advantage if a high back pressure is carried. By proper timing of the valve the compression can be set at any desired value with the minimum of clearance. With the valve placed along the barrel the clearance volume must be made large enough to keep the compression below the initial. As example, with 10 lb. gage (25 lb. absolute) back pressure, 150 lb. steam pressure and the auxiliary valve at 0.3 the stroke, the clearance X is found by the equation $P_1V_1 = P_2V_2$, or $25\ (X - .3V) = 150\ X$, or $X = 6$ per cent of the stroke volume. With an end exhaust valve the clearance may be, say 2 per cent. If Professor Stumpf and other authorities are correct in the claim that large clearance volume is a detriment, then the latter type of auxiliary valve has an advantage over the other type.

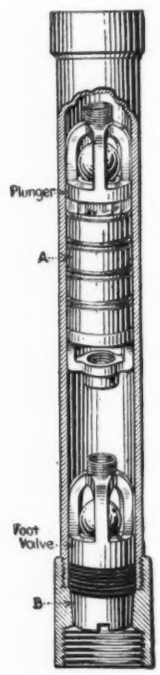
J. M. CASSIDAY.

New York City.

Experiences with a Deepwell Pump

I have read in the Nov. 7 issue with a great deal of interest M. M. Brown's "Experiences With a Deepwell Pump." The design of the pump he used is certainly not to be recommended.

This type of pump is now manufactured with working barrels arranged as shown in the cut. The barrel is made of brass, and its inside diameter is always ¼ to ½ in. smaller than the inside diameter of the drop pipe which connects the working barrel to the power head. The plunger, therefore, can be readily drawn from the well without disturbing the drop pipe.



PRACTICAL DESIGN OF PUMP

As indicated at *A*, the plunger is fitted with leather cups. These cups are necessary for efficient operation, particularly if there is sand in the water.

Referring again to the illustration, it will be seen that the foot valve is not screwed into the working barrel, but is tapered at the bottom *B* and drops into a tapered fitting screwed to the bottom of the working barrel. In order to remove the foot valve, the plunger rod is disconnected at the power head and the plunger is lowered until it rests on the foot valve. It is then only necessary to rotate the plunger rod four or five turns to connect the foot valve to the plunger, and both can be drawn from the well.

If a strainer is necessary, it can be attached to the lower end of the working barrel before it is put down.

Plunger rods made of wood and fitted with iron couplings are usually supplied with this type of pump. The threads on the couplings are of a special pitch to prevent their becoming unscrewed so readily. Wooden rods are preferred to iron, because of the lower power required to oscillate them in the well and to lessen the wear on the drop pipe.

It is obvious that, using the design shown by Mr. Brown, a larger working barrel could be put down a given size of well casing, and, therefore, would have a greater capacity for a given length of stroke than the pump herein described. This, of course, could be taken care of by using a longer-stroke pump or operating at higher speed or by using a double-acting barrel.

Atlanta, Ga. PAUL R. YOPP.

The experiences of Mr. Brown show the danger of buying a pump "of standard make" on the strength of its being standard instead of basing the selection on the merits of the particular equipment in question. The best practice does not employ any cylinder in connection with deepwell power pumps in which it is not possible to withdraw the sucker rod and plunger without disturbing the drop pipe. Exceptions to this are to be found in comparatively small cylinders used in hand pumps or windmill pumps where low price is the main consideration.

Even some rather complicated double-acting cylinders are so arranged that the plunger can be withdrawn and the balls or leathers changed without pulling the drop pipe.

A 4¾-in. (inside diameter) cylinder requires a 5-in. drop pipe, which in turn requires a casing of over 6½-in. inside diameter unless flush-point tubing is used for the drop pipe, in which case an inside diameter of about 6 in. will be large enough for the casing.

Detroit, Mich. K. P. ROYCE.

I was much interested in the experiences of Mr. Brown, as I have charge of four deepwell pumps similar in design to the one shown in the illustration. In one of the wells, which is 300 ft. deep, we have a 3½-in. drop pipe with a 3¼-in. cylinder. The pump is fitted with a differential plunger at the top of the well, which makes it double acting and gives a steadier discharge and more even load on the pump. With a block tackle we can withdraw the rod and plunger and put on new leather crimps and replace any worn rod in about four hours.

We have operated this pump one year at a time without examination, but believe it is better to replace the leather crimps every six months to keep the pump operating at best efficiency. At each examination we change the different lengths of rod to bring the wear of the iron couplings in a different place on the drop pipe. We have found the bronze balls very satisfactory, some of them being in use for over ten years, and they were still tight even when the cylinder was badly scored.

Salem, Ohio. C. E. FREEMAN.

Reducing the Boiler Pressure Quickly in Emergencies

To reduce the steam pressure on a boiler quickly in case of an emergency such as described by R. A. Cultra, in the Nov. 14 issue, I would suggest closing the stop valve immediately, if there is no automatic stop valve on the connection. Then open the boiler-feed valve wide and speed up the pump.

To lower the pressure by pulling open the safety valve would be all right if there were only the volume of steam in the drums to contend with, but as the lowering of the pressure causes rapid formation of new volumes of steam, due to the temperature of the water being above that corresponding to the slowly falling pressure, the lowering of the pressure through the safety valve is a rather slow process. The difficulty is further increased if the boiler is fired by a mechanical stoker, as it requires considerable time to draw the fire or to cool it down sufficiently, during which time considerable steam will be generated from the heat of the furnace.

Feeding comparatively cold water, on the other hand, supplemented by the blowing of the pop valve, will give quicker results.

For instance, a 5,000-sq.ft. boiler operating at normal rating would give an evaporation of approximately 17,250 lb. of steam per hour, or 287.5 lb. per minute.

If the feed valve to this boiler is thrown wide open, the capacity of pump, size of connections, etc., will under ordinary conditions allow a rate of feeding into this boiler equal to at least three times normal rating from the first start, and the full capacity, as soon as the pressure starts to drop and the check valves on the other boilers automatically close. At this rate of feeding there will be $3 \times 287.5 = 862.5$ lb. of water per minute entering the boiler at a temperature generally much below that corresponding to the steam pressure, say 180 deg. as against 365 deg. in the boiler. Each pound of water entering the boiler mixes with the general circulation and has to absorb first 365 — 180 = 185 B.t.u. plus an additional 857.7 B.t.u. before it

will be evaporated into steam; in other words, it has an immediate cooling effect equal to a withdrawal of $3 \times 287.5 (857.7 + 185) = 899{,}328$ B.t.u. per min. and will reduce the pressure in a comparatively short time. Obviously, it will be necessary to blow down if this flow is to be maintained for any length of time.

Youngstown, Ohio. R. CEDERBLOM.

Importance of Operating Instructions

The article, "Operating Instructions for Hydro-Electric Stations," by Ralph Brown, in the Nov. 28 issue, is of particular interest to the operating engineer. Not infrequently he finds himself in serious difficulties because he is not familiar with the proper operating procedure, or expensive machinery is seriously damaged, which might have been avoided if the operator had been given the necessary instruction to handle intelligently the equipment in his charge.

Operating men pretty generally realize the importance of never attempting to open a loaded disconnector, yet errors of this nature occasionally occur and sometimes result in serious and unexpected difficulties. In a 48,000-kva. station, the arcing that resulted when a 6,600 generator disconnector was opened, destroyed two disconnectors and current transformers, burned out some of the switchboard instruments owing to high voltage being applied to them and control wiring, and injured the operator who opened the loaded disconnector. The generator bus was cleared from outside sources of power, and upon failure of the camp lights men off duty ran to the station to assist the two men there. Because the station apparatus was made dead to clear the trouble, the governor oil pressure, which was normally maintained by alternating-current motor-driven pumps, failed, and the turbine gates could not be operated. The head gates, which were also operated by alternating-current motors, could not be closed, and although a hand-operated pump formed part of each main-unit governor, they were not employed to close the turbine gates, and the units were beyond control for a considerable time. Finally, power was obtained from an incoming line, and conditions restored to normal in so far as the damaged apparatus permitted. While the time required to restore conditions to normal was evidently due to a decided lack of capable leadership, which is very essential during such an emergency as this, the failure of the operating men congregated in the station to co-ordinate their efforts indicates what may be expected when inexperienced or improperly trained operators face an unusual situation.

Had the hand pumps been utilized for the purpose for which they were installed, the turbines could have been brought to speed in a few minutes, an exciter could have been operated by direct manual control, certain switches closed manually, the damaged section of the 6,600-volt bus isolated by opening a bus sectionalizing switch, and station service restored by operating a generator on the undamaged section of the bus.

In a 15,000-kva. station the acting chief operator, while engaged in cutting out a 6,600-volt bus, opened one loaded generator disconnector successfully, but was slightly burned about the face by the arc that resulted when the second disconnector was opened. The arcing spread to such an extent as to involve the near-by 60,000-volt bus, and as the switchboard operator was untrained, he did not take intelligent steps to clear the trouble until directed to do so by the injured man, who made his way to the switchboard. By this time a generator had failed, and a number of armature coils were destroyed before the trouble was cleared. Besides a brief interruption affecting the entire system, service was suspended from this particular station for 40 min. and a generator was put out of commission, all because of an error in opening a loaded disconnector.

Had the man on duty at the switchboard been properly trained, immediate action on his part would have lessened the extent of the damage and would have enabled service to be resumed in less than 40 minutes. Merely because the opening of the loaded disconnector was the cause of the trouble, the failure of the operator to handle the situation properly should not be condoned, for similar station difficulties could arise from a number of different causes. In a number of hydro-electric stations men have been found who were not qualified to control unusual operating difficulties, simply because no attention had been paid to their training or to the extent of their real knowledge of station operation. This condition of affairs should not exist, yet it does exist and is more of a reflection on the management than on the operators employed in such stations. So far as the writer is aware, such conditions can be remedied only by the consistent use of standardized operating instructions. C. M. KING.

Philadelphia, Pa.

Is Large Furnace Volume Necessary?

I was much interested in the discussion of marine boilers and furnace volumes, that took place at a recent meeting of an engineering society, at which the views expressed by some of the speakers would seem to make the furnace volumes that are used at the present time appear ridiculous. I have held this view for some time, and in a letter published in the June 7, 1921, issue of *Power* I expressed my opinion on this question.

Furthermore, the idea that a hot surface like that of incandescent brick is necessary for good combustion is disproved by what the Scotch boiler does. The fact of the matter is that if air in the right quantity is admitted to combustible gases at the right point, combustion will take place immediately, and further volume does no good.

It has been demonstrated by tests, conducted on Scotch boilers, that air admitted at the bridge wall would convert CO of 15 per cent from a point 16 in. in front of the bridge wall to 15 per cent CO_2 16 in. back of the bridge wall. After that was done, nothing more was necessary and the furnace volume above did no good. Of course that volume had to exist in order to furnish a tube plate for the tubes.

It is not generally realized what a good thing horizontal travel of gas is, for gases that have an excess of combustible in one part of the furnace get mixed up with gases having excess of air in other parts, and the best combustion then takes place. In the case of the transversely baffled water-tube boiler, where the gases all go up in approximately parallel streams, there is little chance of the good and bad gases getting together. This is also true of the vertical fire-tube boiler, and it is about the only defect of that type. If that were not so, it would be among the most economical boilers, and it is now, if the firing is done in such a way as to have the gas of the same nature from all parts of the grate and with sufficient air. F. W. DEAN.

Boston, Mass.

QUESTIONS AND ANSWERS

Determination of Chlorine in Feed Water

What is the simplest method for determination of chlorine in boiler feed water and what quantities of chlorine are found in natural waters? C. Q.

Dissolve 5 grains of pure crystalline silver nitrate in distilled water and dilute to 1 liter. One cubic centimeter of the solution is equivalent to 0.001 gram chlorine. If the water to be tested shows by qualitative analysis a small amount of chlorine present, 250 c.c. of the water should be evaporated to about 50 c.c., allowed to cool, three drops of a saturated solution of potassium chromate added, and the silver nitrate dropped carefully from a burette until a faint permanent red color is produced in the water. This point indicates that all the chlorine has combined with the silver and that any additional silver solution added forms silver chromate. For instance:

250 c.c. of the water used for examination.
250 c.c. of the water required 1.3 c.c. silver nitrate solution.
1,000 c.c. of the water required 5.2 c.c. silver nitrate solution.
Equivalent to 0.0052 gram of chloride per liter.
Equivalent to 0.52 part chlorine in 100,000 parts of water.
Equivalent to 5.2 parts chlorine in 1,000,000 parts of water.

Results from a large number of analyses of various waters indicate amounts of chlorine present as follows:

Rain water	Traces to 1 part per 1,000,000
Surface water	1 to 10 parts per 1,000,000
Subsoil water	2 to 12 parts per 1,000,000
Deepwell water	Traces to large quantities

Arrangement of Blowoff Tank

We have two water-tube boilers, each 2,500 sq.ft. of heating surface, which are connected to a blowdown tank 3 ft. in diameter by 5 ft. long with a 2½-in. boiler blowoff line connected at the top and a 2-in. outlet near the bottom. This tank is located in the boiler room just behind one of the boilers. We cannot keep the manhole gasket of the tank tight, and the leakage causes much annoyance to the boiler-room force. The only other place available for the tank would be to place it underground outside of the boiler house, but when so placed the tank would be filled with water all the time, as the discharge would have to rise to the surface of the ground. Would this arrangement be practical and safe? E. T.

A blowoff tank is for the purpose of receiving the boiler blowoff, with discharge to the atmosphere at a reduced pressure and temperature of water and thus do away with the nuisance that would result from blowing off directly to a sewer or into the atmosphere.

The tank should act as a vessel in which the hot water can expand into steam at lower pressure than boiler pressure, and for that purpose the tank should not be allowed to become more than about half filled with water. Its top should be vented to the atmosphere with a pipe several sizes larger than the blowoff inlet to the tank with the vent pipe carried full size to a point where the escape of the low-pressure steam would be no more objectionable than the exhaust from an engine. For the requirements stated, it would be impractical to place the blowoff tank below ground where it would be kept full of water and could not fulfill the principal purposes of a blowoff tank. Undoubtedly, the trouble experienced from leakage of the manhole gasket will disappear if the tank is provided with a vent pipe about 4 in. in diameter and is not permitted to become more than about half full of water.

Changing from Swinging to Slotted Eccentric Impractical

An automatic engine has a riding cutoff valve that is controlled by a shaft governor which swings the eccentric around on the shaft. Could the engine be run with a shaft governor operating a slotted eccentric? R. J. S.

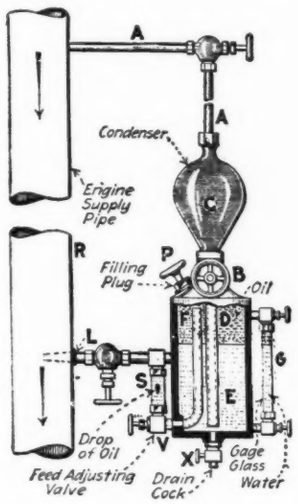
When the governor swings the eccentric around on the shaft, the variation of cutoff is effected by changing the angle of advance of the eccentric and the valve travel is constant. With a slotted eccentric there would be variation of the eccentricity and variation of valve travel, and consequently a valve designed for constant travel would not be properly operated by a governor controlling a slotted eccentric.

Operation of Engine Cylinder Lubricator

What is the principle of operation of an engine cylinder lubricator and how is it connected and used? C. S.

The motive power of an ordinary double-connected cylinder lubricator is the hydrostatic pressure of a column of water that is maintained by condensation of steam admitted through the upper connection of the lubricator with the steam pipe. A head of water above the oil in the lubricator, assisted by superimposed steam-pipe pressure, forces the oil out of the lubricator into the steam pipe against the steam-pipe pressure. The general arrangement of the connections, provision for keeping the oil separated from the condensing water and method of regulating the supply of oil, are illustrated in the figure. Steam admitted from the engine steam supply pipe *R* through the upper connection *A* is condensed in *A* and in the condensing chamber *C*. When

the valve *B* is open, the condensate can flow down through the pipe *D* to the bottom of the oil reservoir *E*. Water thus delivered displaces oil in *E* and the level of the water in *E* is shown by the gage glass *G*. The oil is trapped under pressure in the upper part of the



ENGINE CYLINDER LUBRICATOR

oil chamber, from which it is forced out through the bent pipe *F*, open at its upper end near the top of the oil chamber, and is thence forced out through the adjusting valve *V* upward through the oil sight feed glass *S* and delivery pipe *L* connected with the steam pipe *R*. As indicated by dotted lines, the delivery pipe usually is extended with perforations for some distance into the main steam pipe, or some form of spoon or nozzle is provided for breaking up and atomizing the oil as it is delivered into the steam pipe.

With the valve *V* closed and valve *L* open, the oil sight feed glass *S* becomes filled with water formed by condensation of steam entering the pipe *L*. To fill the lubricator with oil, first close valves *B* and *V* and then open drain cock *X* and plug *P* and, when all water is drained out of *E*, close the drain cock *X* and pour in the oil at *P*. For proper operation of the lubricator the condenser *C* must be full of water or the oil will become broken up by admission of steam to *E*. In case *B* has been left open or sufficient time has not been allowed for condensate to fill *C*, the lubricator should be completely emptied and permitted to cool with the valve *B* tightly closed. Then after refilling, open *B* and adjust the regulating valve *V* to the desired rate of feed indicated by drops of oil rising in the oil sight feed glass *S*. The lubricator should be started and stopped with the engine, for otherwise it would continue feeding and thus waste oil.

Removing Large Slotted Screws from Turbine Nozzle Plates

In attempting to replace nozzle plates in small turbines for use with a change of steam pressure, the fillister-head machine screws are found to stick tightly. The use of ordinary screwdrivers and cape chisel fails to start the screws. How can they be removed?

H. G. F.

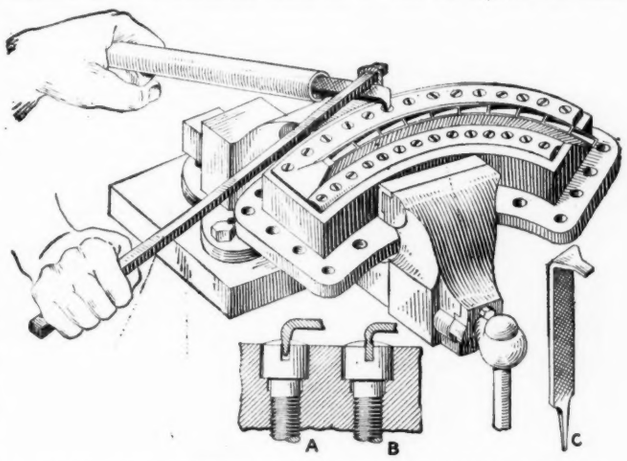
Such screws are set up tightly to prevent leakage. They should be removed without great difficulty if inserted with cylinder oil and graphite. Even then they become stuck by the heat of the steam and are difficult to remove with an ordinary straight screwdriver.

The most effective screwdriver for the purpose is one having the point offset at right angles as this form is more convenient for exerting greater turning force and pressure on the bit, as shown in the illustration, than would be possible with a straight screwdriver. It may be possible to use a small hand ratchet for operation with a suitable bit. A screwdriver should be made from first-class hexagon tool steel fitting the slots of the screws to their full depth. Such a steel is not easy to find; ordinary grades will not temper to sufficient strength.

Care should be taken to have the screwdriver fit the slot accurately, principally at the bottom, with clearance at the top, as shown in the illustration at *B*. A wedge form such as at *A* will bring the whole pressure at the very tops of the screws, and will quickly render the slots useless. Fit accurately to an individual screw, if possible with sharp square corners, as a tight even fit is required. When the slot is in good shape and the bit is properly fitted, it is not necessary to hold the bit down into the slot with an auxiliary lever, as shown.

In tempering the screwdriver point, it should be heated only to a cherry red and drawn to a deep blue or even softer, so as to obtain maximum strength rather than hardness that would cause the point to break off. When forged from a file, as shown at *C*, a successful tool had been made by simply allowing the forged point to cool slowly in the air. With some grades of steel, quenching in oil is often satisfactory. Some experimenting is usually necessary in order to bring out the greatest strength of the material.

When backing out the screws, the nozzle plate and casting can be securely held in a vise as shown or can



REMOVING SCREWS FROM TURBINE NOZZLE PLATE

be held between "stakes" on the bed of a planer or lathe. Before attempting to remove the tight screws, they should be left moistened with kerosene over-night. Just prior to applying the screwdriver, jar the nozzle plate with a small flat-faced hammer or drift. Steady pressure should be applied on the screwdriver, avoiding jerks.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Feed Heating for High Thermal Efficiency*

By LINN HELANDER
Steam and Combustion Engineer, Westinghouse Electric & Manufacturing Company

THIS paper considers, first for a theoretically perfect power plant and then for typical 25,000-kw. plants, the question of the best feed-water temperature. This is investigated purely from the thermal point of view, no account being taken of investment, operating costs, etc. The practical cases considered include heating by house-turbine exhaust alone and in combination with single or multiple bleeding of the main unit. Each of these conditions is considered both with and without economizers.

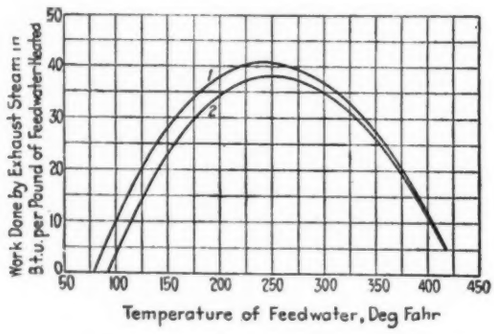


FIG. 1—THEORETICAL WORK DONE BY HOUSE-TURBINE OR BLED STEAM

The final conclusions from the computations are as follows: For power plants using single- or multiple-stage feed-water heaters of the condensing type, the temperature of the boiler feed water as it leaves the heaters should not be less than 150 deg. F. when using economizers and probably not more than 260 deg. when not using economizers, although certain conditions permit improving plant thermal efficiency up to 300 deg. F., corresponding to 72 lb. absolute pressure in the heater. The maximum of this range was established by consideration of fuel charges only. The lower limit of 150 deg. F. is based on mechanical difficulties and is below the lowest temperature justified by fuel charges only in the 25,000-kw. plant investigated.

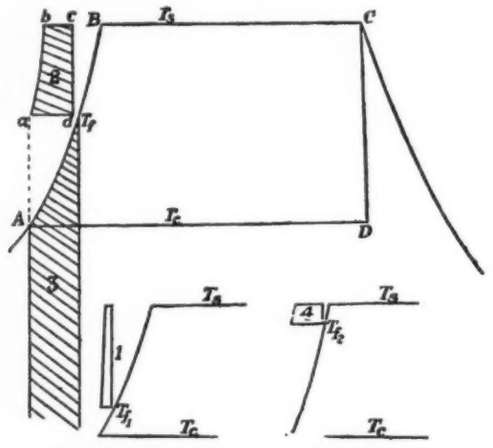


FIG. 2—TEMPERATURE-ENTROPY DIAGRAM FOR SINGLE-STAGE HEATING

Taking up first the case of a theoretically perfect power plant, it is evident that there must be a definite feed-water temperature that gives the greatest plant thermal efficiency for any given set of conditions.

With single-stage heating, either by bled steam or house-turbine-exhaust, this point occurs when the total power produced from that portion of the steam which goes to heat the feed water is a maximum. Assuming, for the discussion of this theoretical case, that the heating steam comes from a house turbine whose exhaust raises the feed water to its own temperature, there are evidently two limiting feed-water temperatures which would make this power zero. These are (1) the temperature of the main condensate, where no exhaust steam could be used and (2) the temperature corresponding to the boiler pressure, where considerable steam would be required but without any pressure drop to produce power in a house turbine. For any intermediate temperature, the total work done by the theoretical house turbine must be the product of the work available per pound expanding to the given temperature by the number of pounds required to heat the feed water from the main condensate temperature to the given temperature.

When plotted with feed temperatures as abscissas, the work done per pound is a practically straight line sloping down from a maximum at the lowest feed temperature to zero at the highest, while the curve for weight of steam required to heat the feed water is another straight line, sloping up to the right from zero at the lowest feed temperature to a maximum at the highest.

The total work available is the product of these two curves and is represented by a curve rising from zero at the main-condensate temperature to a maximum about halfway between condensate and boiler temperatures and then falling to zero again at boiler temperature.

Fig. 1 shows two such curves, for initial steam at 325 lb. gage and 200 deg. superheat. Curve 1 is for a condensate temperature of 79 deg. and shows the best feed temperature around 240 deg., while curve 2 is for a condensate temperature of 92 deg. and shows best economy at a feed temperature of approximately 260 degrees.

A similar curve drawn for two-stage heating with the same initial steam condition and a 79-deg. condensate (29 in. vacuum) gives the best feed temperature at approximately 300 deg., if drawn on the basis that each of the two bleeder heaters supplies the same amount of heat to the feed water. As the number of bleeder heaters is increased, the best feed temperature increases until it reaches boiler temperature for an infinite number of heating stages. As is well known, the theoretical plant efficiency equals that of the Carnot cycle at this point.

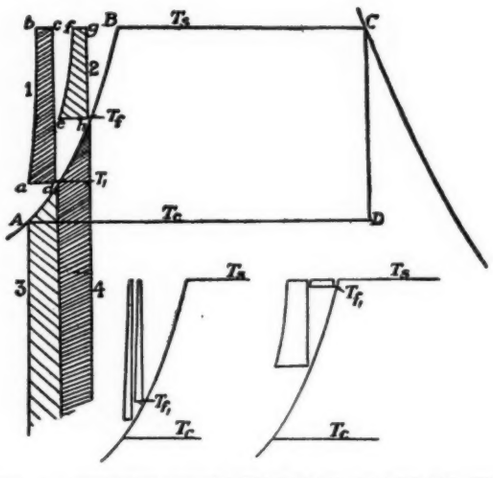


FIG. 3—TEMPERATURE-ENTROPY DIAGRAM FOR DOUBLE-STAGE HEATING

*Abstract of paper presented at the annual meeting of the American Society of Mechanical Engineers, New York City, December, 1922. A brief abstract of this paper and of the discussion that followed its presentation was given in Dec. 12 issue of *Power*.

The case of single-stage heating may be illustrated by the temperature-entropy diagram shown in Fig. 2, where the large area *ABCD* represents the work done by steam passing through the main unit. Here the shaded area (2) represents the work obtained from the heating steam which condenses at T_f and heats the feed water to the same temperature. The shaded area (3) represents the total heat added to the feed water to heat it from the condenser temperature T_c

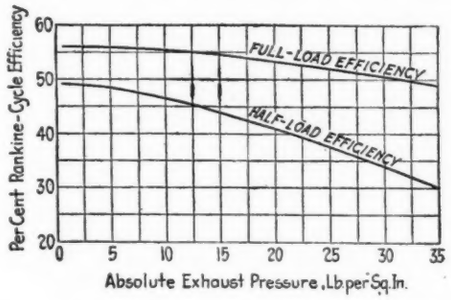


FIG. 4—RANKINE-CYCLE EFFICIENCIES OF HOUSE TURBINES FOR CASE 1

The curves are for the 1,500-1,700 kw. house turbines. For the 650-kw. house turbine the Rankine-cycle efficiency is substantially the same as for Case 2 (see Fig. 5).

to T. This area must be equal to that under the line *ad*. Areas (1) and (4) in the small sketches below the main diagram show how the available work from the heating steam is reduced when the feed temperature is appreciably below or above the most economical point.

Similar diagrams for double-stage heating for equal heat transferred in the two stages are shown in Fig. 3. The best feed temperature for this theoretical case is that in which the sum of the work represented by the areas (1) and (2) is the maximum. Both Fig. 2 and Fig. 3 are for dry saturated steam.

With this preliminary study of a theoretically perfect station, we can turn to the consideration of an actual 25,000-kw. station with various combinations of apparatus. The principal[1] assumed conditions (water rates, etc.) are as follows:

Net station load	25,000 kw.
Load on auxiliary bus	1,300 kw.
Gross station load	26,300 kw.
Steam consumption of the main unit when carrying the gross station load:	
	Case 1: 279,000 lb. per hr.
	Case 2: 270,000 lb. per hr.
Pressure of steam at throttle	330 lb. gage
Boiler pressure	350 lb. gage
Superheat	200 deg. F.
Vacuum on main unit	29 in.
Temperature of condensate	75 deg. F.
Slope of Willans Line of main unit	Case 1: 12 lb. per kw-hr.
	Case 2: 9 lb. per kw-hr.
Internal Rankine-cycle efficiency of bled steam based on steam pressure after throttle	Case 1: 67 per cent
	Case 2: 80 per cent
Boiler efficiency when not using economizers	78 per cent
Boiler efficiency when using economizers, but not including the economizer efficiency	75 per cent
Coefficient of heat transmission through economizers per deg. mean temperature difference between flue gases and water	5 B.t.u. per sq.ft.
Temperature of gases entering economizers	580 deg. F.
Percentage of recoverable heat recovered by economizers	85 per cent
Flue gases per pound of coal	19 lb.
Heating value of coal	13,500 B.t.u. per lb.
Ratio of the load developed by the boilers to the full-load rating of the boilers when using economizers	2.25

For each arrangement of feed-water heating, two cases, case 1 and case 2, were worked out. These give a comparison that shows the effect of varying the total steam consumption, the slope of the Willans Line of the main unit and the percentage of theoretical efficiency actually obtained.

The Rankine-cycle efficiencies of the various house turbines used in the two cases are given in Figs. 4 and 5. The former shows only the 1,500- to 1,700-kw. house turbine, the efficiency of the 650-kw. house turbine for case 1 being practically the same as that for case 2, as shown in Fig. 5. An average Rankine-cycle efficiency of 80 per cent was used for steam bled from the main unit.

[1]The original paper gives also the assumed radiation losses, drip losses and other minor data.

All auxiliaries in these stations were considered as being normally motor-driven. Surface condensers were used on the main units and the condensate, before going to the feed-water heaters, was passed as cooling water through the evaporator system supplying boiler-feed makeup so long as this operated on exhaust steam. When the temperature of the exhaust steam was too low to evaporate the water efficiently and the use of live steam became necessary, the

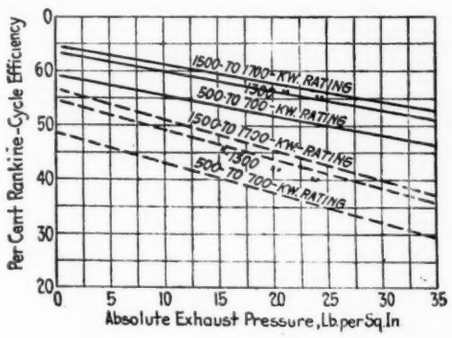


FIG. 5—RANKINE-CYCLE EFFICIENCIES OF HOUSE TURBINES FOR CASE 2

These curves apply where the house units are designed for the back pressures at which they are to operate.

condensate was returned directly to the feed-water heaters, and the water used for the evaporator condenser was taken from the boiler-feed water previously heated in the economizers or in the feed-water heaters.

With this arrangement the use of live steam on the evaporator did not materially affect the heat balance, and the pressure of the exhaust steam used for heating the feed water was determined by the pressure within the feed-water heater rather than by the requirements of the evaporator system. A schematic arrangement of these plans is shown in Fig. 6.

Although economizers are shown in this diagram, heat balances were also worked out for two arrangements using single-stage heating and no economizers. In one arrangement the auxiliary power was obtained from a house turbine of 650-kw. capacity, or one-half the total auxiliary load, the

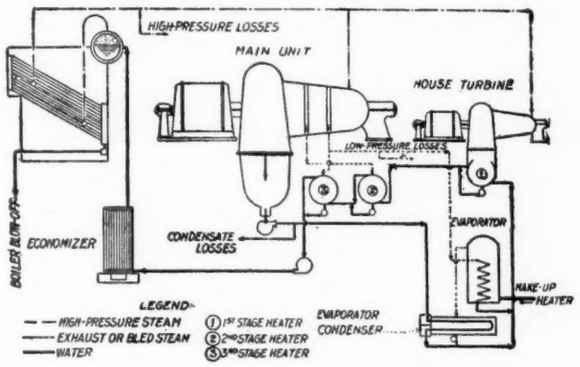


FIG. 6—DIAGRAM OF STATION LAYOUT

Arrangement for three-stage feed-water heating, showing distribution of steam and various sources of water and steam losses. The condensate from the main unit is circulated through the condenser of the makeup-water evaporator system before going to the feed-water heater.

remainder being carried by the main unit. Steam, in addition to that supplied by the house turbine, was bled from the main unit for heating the feed water. The other arrangement used a house turbine with its point of best economy at 1,600 kw. for case 1 and 1,700 kw. for case 2. In this case, no steam was bled from the main unit.

As indicated by curves 1 and 2 of Figs. 7 and 8, the first arrangement is apparently the more economical and also

requires, for best efficiency, a slightly higher feed-water temperature.

A comparison of feed-water temperatures for best economy, as indicated by case 1 and case 2 respectively, shows that when economizers are not used there is little effect due to ordinary variations in the Rankine-cycle efficiency of the bled steam, the efficiency curves of the house turbine, or the slope of the Willans Line of the main unit. With economizers the Willans Line has a somewhat greater effect. For establishing the proper feed-water temperature for the best efficiency, minute accuracy in determining the efficiencies of the various turbine units is not required.

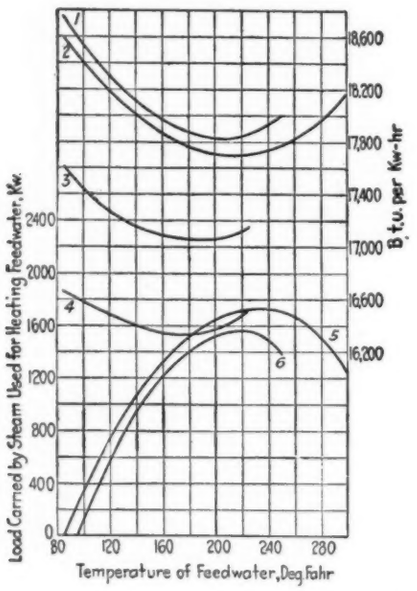


FIG. 7—SINGLE-STAGE HEATING—CASE 1

(Steam pressure, 330 lb. gage; superheat, 200 deg. F.; vacuum on the main unit, 29 in.)

Curve 1—B.t.u. per kw.-hr. using a 1,600-kw. house turbine and not bleeding the main unit. Economizers were not used.
Curve 2—B.t.u. per kw.-hr. using a 650-kw. house turbine and bleeding the main unit. Economizers were not used.
Curve 3—B.t.u. per kw.-hr. using a 650-kw. house turbine, economizer of 21,875 sq.ft. area and bleeding the main unit.
Curve 4—B.t.u. per kw.-hr. using a 650-kw. house turbine, economizer of 49,450 sq.ft. of surface and bleeding the main unit.
Curve 5—Load developed by the steam used for heating the feedwater when using a 650-kw. house turbine and bleeding the main unit.
Curve 6—Load developed by the 1,600-kw. house turbine supplying exhaust steam to the feed-water heater.

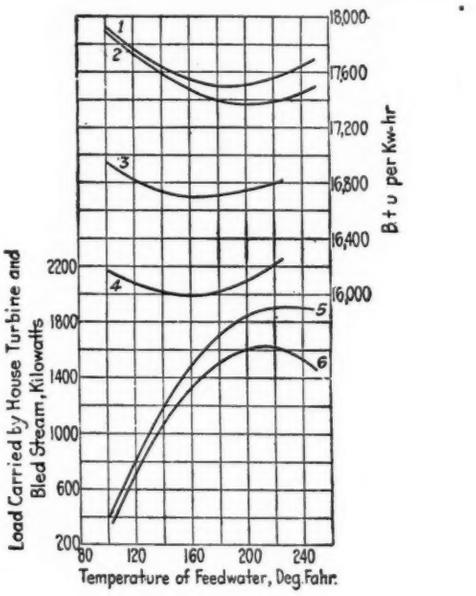


FIG. 8—SINGLE-STAGE HEATING—CASE 2

(Steam pressure, 330 lb. gage; superheat, 200 deg. F.; vacuum on the main unit, 29 in.)

Curve 1—B.t.u. per kw.-hr. using a 1,700-kw. house turbine and not bleeding the main unit. Economizers were not used.
Curve 2—B.t.u. per kw.-hr. using a 650-kw. house turbine and bleeding the main unit, not using economizers.
Curve 3—B.t.u. per kw.-hr. using a 650-kw. house turbine, economizer of 21,875 sq.ft. area, and bleeding the main unit.
Curve 4—B.t.u. per kw.-hr. using a 650-kw. house turbine, economizer of 49,450 sq.ft. of surface, and bleeding the main unit.
Curve 5—Load developed by the steam used for heating the feed water using a 650-kw. house turbine and bleeding the main unit.
Curve 6—Load developed by the 1,700-kw. house turbine supplying exhaust steam to the feed-water heater.

Heat balances were also made for four stages with and without economizers. For case 2, using the 650-kw. house turbine (without economizers), the heat consumption per kilowatt-hour and the gain per stage would be approximately as follows, for various numbers of stages:

Number of Stages	B.t.u. per Kw.-Hr.	Saving Over Preceding Number of Stages, B.t.u
0	18,000	
1	17,300	700
2	16,950	350
3	16,800	150
4	16,700	100
5	16,640	60

So many factors enter into the determination of the proper feed-water temperature of a plant that figures determined for one station should not be directly applied to another. As seen, the temperature should be lower for plants using single-stage heating than for those using multiple-stage heating, and they should also be lower for plants using economizers than for plants not using economizers. Efficiencies of auxiliary apparatus, as well as of the main generating units have their influence. If the feed-water temperature be raised much above 212 deg. F., factors incident to the use of pressures well above atmosphere in the auxiliary exhaust pipes come into play. The proper feed-water temperature is dependent somewhat upon the initial steam pressure and temperature and on the temperature of the condensate, increasing as these increase.

It is quite impossible, therefore, to determine, except within wide limits, feed-water temperatures applicable to all plants. The purpose of the present paper has been to indicate in a broad way the effect of feed-water temperatures on power-plant efficiency (leaving out the matter of costs) and to give some basis for estimating the sacrifice in fuel needed to assure practical operation of the feed-water heating system as laid out for a particular station.

Italy is at present utilizing hydro-electric energy amounting to 1,192,000 hp., according to the Superior Hydraulic Council of that country. In addition, concessions have been granted for a total of 50,000 hp., of which over 30,000 hp. is in the Department of Perugia (Umbria). The figure of 1,192,000 hp., however, represents only about 60 per cent of the total water power conceded by the government up to the present. When works under construction or in project are completed, Italy will have 1,986,000 developed water horsepower.

The construction of a hydro-electric station on the Rhine at Kembs is planned. The proposed plant will develop 80,000 hp., to be used in the Mulhouse district. It is stated that the demand for power there is in advance of the present supply.

The leading electric-light companies of Japan (largely hydro-electric) show earnings for the first half of 1922 that compare favorably with the second half of 1921. These earnings were based on an 8 to 14 per cent annual dividend.

News in the Field of Power

Water Power Goes Begging

Who Will Develop Power at Federal Dam? Government Wants Speedy Answer

DELAY occasioned by the conflict between rival contenders for the available power at the Government High Dam in the Mississippi River between St. Paul and Minneapolis already has cost the Federal Government nearly $700,000. If the Minnesota legislature does not quickly take action in the matter, it is expected that the Federal Power Commission will step in and settle it without further delay. The question has been further complicated by the filing of an application by Henry Ford.

The trouble was precipitated when an association of leading citizens induced the city of St. Paul to file an application for the right to develop the power available at the High Dam. The St. Paul association is trying to establish a new industrial area, and as a part of that campaign obtained the promise of Henry Ford to build a factory employing 5,000 men, with the understanding that the association would transfer its power rights to him. This action caused the Northern States Power Co. to file a conflicting application. Still another application was filed by the city of Minneapolis, as noted in *Power* for Sept. 5. The Federal Power Commission held a hearing but delayed its decision so as to give the Municipal Electric Corp., composed of the cities of St. Paul and Minneapolis and the University of Minnesota, an opportunity to obtain the necessary state legislation to construct and operate the power plant.

Situation Is Complicated

It is apparent, however, that there is no chance for the two cities to get together on any such proposition, and many believe that the Federal Power Commission would hardly grant a license permitting such an indirect arrangement as that of the scheme involving the city of St. Paul, the St. Paul association and Henry Ford.

If it were not for Mr. Ford's policy of not making any contracts with public utility corporations, the logical way to handle the proposition would be to grant a license to the Northern States Power Co., which has a large generating and distribution system and could utilize all of the secondary power. So far as the Federal Government is concerned, an equally satisfactory solution would be to grant a license to Mr. Ford, requiring that he install equipment so as to make full use of the secondary power and that he sell all surplus to public utility corporations. This arrangement would be satisfactory to all concerned, it is believed, except the city of Minneapolis, which feels that it has a half interest in the power rights and that by such an arrangement St. Paul would get more than its share.

As a result of the Government's large investment in the dam it is known that federal officials are disposed to make a final settlement of the project just as soon as the Minnesota legislature indicates its intention in the matter.

Coal Commission Is Active

Recommendations, Ready Jan. 15, Will Be Drastic—No Mediation in Wage Disputes

WHILE the period of activity of the President's coal commission is fast approaching an end, it is believed that enough data may be analyzed to permit of a preliminary report that will have weight with the industry as well as with the public. Chairman Hammond states emphatically that the report will not be a "wishy-washy" affair. Instead, it will contain some rather drastic suggestions, as it is believed that bold surgery is necessary if the source of the ills of the coal industry is to be reached.

Machinery such as the commission must set up is ponderous. It takes a long time to get it into working order, but once in operation a great deal may be accomplished in a short time. Jan. 15 is the date that hangs over the commission like the sword of Damocles, as the preliminary report must have been completed when that day arrives.

That the commission will not undertake anything that can be interpreted as mediation in wage scales was emphasized by Mr. Hammond and by Dr. Smith. Wage-scale adjustments are the responsibility of the operators and mine workers, it was said, and while the commission will use its moral influence to induce them to get together and will emphasize the far-reaching consequences of another strike, the concrete work of the commission will consist merely in submitting to Congress such facts and conclusions as it may reach.

Over-expansion in the coal industry, Mr. Hammond states, is not confined to the producers. Both wholesalers and retailers, he declared, complain because there are too many persons engaged in the distribution of coal.

A bill amending the coal-commission act, to authorize the commission to gather information by sworn questionnaires, with penalties for failure to answer and for false statements, has been introduced in Congress and its early passage is expected.

Experiments with two grades of Alaskan coal will be completed in the near future on the battleships "Texas" and "Oklahoma." These will comprise the use of 600 tons of each kind under test conditions and further use of the supply under operating conditions.

A.S.M.E. Adopts Ethics Code

Rules of Conduct Drawn Up by Men From Leading Engineering Societies

A CODE of ethics, governing its membership of approximately 20,000, was adopted by the American Society of Mechanical Engineers at the recent annual meeting. Ultimately it is expected that this code, prepared by a joint committee of the national engineering societies, will apply to the entire engineering profession.

The mechanical engineers are the first to adopt the code, according to the chairman of the joint committee, Prof. A. G. Christie, of Johns Hopkins University. This action, Professor Christie stated, marks an advance in engineering ideals and places the profession in a position analogous to the professions of law and medicine.

The code commands loyalty to country, personal honor, fairness to contractors and workers, and interest in the public welfare. Betrayal of professional confidences, undignified or misleading advertising, and questionable professional associations and practices are prohibited.

Full Text of Code

The text of the code, as given out in New York City by John L. Harrington, of Kansas City, new president of the American Society of Mechanical Engineers, follows:

Engineering work has become an increasingly important factor in the progress of civilization and in the welfare of the community. The engineering profession is held responsible for the planning, construction and operation of such work and is entitled to the position and authority which will enable it to discharge this responsibility and to render effective service to humanity.

That the dignity of their chosen profession may be maintained, it is the duty of all engineers to conduct themselves according to the principles of the following Code of Ethics:

1. The engineer will carry on his professional work in a spirit of fairness to employees and contractors, fidelity to clients and employers, loyalty to his country and devotion to high ideals of courtesy and personal honor.

2. He will refrain from associating himself with or allowing the use of his name by an enterprise of questionable character.

3. He will advertise only in a dignified manner, being careful to avoid misleading statements.

4. He will regard as confidential any information obtained by him as to the business affairs and technical methods or processes of a client or employer.

5. He will inform a client or employer of any business connections, interest or affiliations which might influence his judgment or impair the disinterested quality of his services.

6. He will refrain from using any improper or questionable methods of soliciting professional work and will de-

cline to pay or to accept commissions for securing such work.

7. He will accept compensation, financial or otherwise, for a particular service, from one source only, except with the full knowledge and consent of all interested parties.

8. He will not use unfair means to win professional advancement or to injure the chances of another engineer to secure and hold employment.

9. He will co-operate in upbuilding the profession by exchanging general information and experience with his fellow engineers and students of engineering and also by contributing to work of engineering societies, schools of applied science and the technical press.

10. He will interest himself in the public welfare in behalf of which he will be ready to apply his special knowledge, skill and training for the use and benefit of mankind.

The joint committee which drew up the code was composed as follows: American Society of Civil Engineers—C. C. Elwell, New Haven, Conn.; A. M. Hunt, New York City; American Institute of Mining and Metallurgical Engineers—J. Parke Channing and Philip W. Henry, New York City. American Society of Mechanical Engineers—Prof. A. G. Christie, Johns Hopkins University, Baltimore; H. J. Hinchey, Chicago; Charles T. Main, Boston; J. V. Martenis, Minneapolis; Robert Sibley, San Francisco. American Institute of Electrical Engineers—Prof. Comfort A. Adams, Harvard University; C. Paccioli, Pittsfield, Mass.; George F. Sever, Toronto, Ont.; L. B. Stillwell, New York City. American Society of Heating and Ventilating Engineers—Frank T. Chapman and Perry West, New York City; S. A. Jellett, Philadelphia.

Engineering Papers at Science Society's Meeting

At the annual meeting of the American Association for the Advancement of Science, to be held Dec. 26-30 at the Massachusetts Institute of Technology, Cambridge, Mass., there will be three sessions of especial interest to engineers, as noted in the following extract from the program:

Thursday Evening, Dec. 28.—An illustrated lecture on engineering and scientific development in South America, by Calvin W. Rice, secretary of the A.S.M.E.

Friday Forenoon, Dec. 29.—A joint session of Sections M (Engineering) and K (Social and Economic Sciences), on some engineering aspects of the general problem of conservation. Doctor John T. Black, former Health Commissioner of Connecticut, will speak on "Conservation and Industrial Waste." There will be a paper by O. C. Merrill, secretary of the Federal Power Commission, on "Federal Water-Power Policy," also a paper on the "Conservation of Power," by William S. Murray, and one on "Problems of Flood Control," by Gen. Harry Taylor

Friday Afternoon, Dec. 30.—The regular session of Section M, in charge of F. M. Feiker, vice-president for the Section. The address of J. B. Tyrrell, retiring vice-president for Section M, will be given, on the "Growth of the Mining Industry in Canada." Other papers include "The Engineer in His Relation to Civilization," by Dr. Ira N. Hollis, president of Worcester Polytechnic Institute; "New Phases of Engineering Education," by Prof. C. F. Scott, of Yale University, president of the Society for the Promotion of Engineering Education, and "Prevention of Waste in Industry," by Mr. Harrington Emerson, of the Federated American Engineering Societies.

Investigate Process Fuel

Mixture of Oil and Coal Dust Being Tested with View to Promoting Greater Use

UNOFFICIAL tests under government supervision are being made at the Post Office Department building in Washington to determine certain qualities of Trent-Amalgam, a patented process fuel composed of about 30 per cent fuel oil, mixed with soft-coal dust. It is delivered at about the price of bituminous coal or a little cheaper. In combination it has the characteristics largely of anthracite. It burns with a fierce blaze for about thirty seconds until the surface oil is consumed, after which the surface becomes coked.

This product has been on the market several years, but production has been confined to the original plant on the outskirts of Washington. This plant is running to capacity now, with its full output under contract, and it is said that territory rights recently have been acquired by important interests in the coal fields as an outlet for coal dust which now is wasted.

In Washington, government officials report that this fuel has practically driven the fractional coal dealer out of existence, as it is preferred by those who purchase in small quantities. A profitable business has grown up in peddling the product in small lots. For small consumers it possesses the advantage of not requiring kindling to ignite the fuel.

The tests, to determine comparative heat qualities and other factors, will continue over a period of several weeks. The results are expected to furnish the basis for further experiments to overcome objections to the product because of its oily condition and to determine what place it may occupy as a permanent fuel.

Coming Conventions

American Association for the Advancement of Science; L. O. Howard, secretary, Smithsonian Institution, Washington, D. C. Annual meeting at Boston, Dec. 26-30.

Society of Automotive Engineers; 29 W. 39th St., New York City. Annual meeting at New York City, Jan. 9-12.

American Engineering Council; L. W. Wallace, secretary, 24 Jackson Place, Washington, D. C. Annual meeting at Washington, D. C., Jan. 11-12.

Compressed Gas Manufacturers' Association; John H. Hayes, 120 W. 42d St., New York City. Annual meeting at New York City, Jan. 15.

Marine Engineers' Beneficial Association; George A. Grubb, secretary, Machinists' Bldg., 9th St. and Mount Vernon Place, Washington, D. C. Annual meeting at Washington, Jan. 15-20.

American Society of Civil Engineers, 29 W. 39th St., New York City. Annual meeting at New York City, Jan. 17-18.

Iowa Engineering Society; Lloyd A. Canfield, secretary, 406 Flynn Bldg., Des Moines. Annual meeting at Des Moines, Jan. 23-26.

American Society of Heating and Ventilating Engineers, 29 West 39th St., New York City. Annual meeting: Jan. 23 at New York City, Jan. 24-26 at Washington, D. C.

American Institute of Electrical Engineers, 29 West 39th St., New York City. Mid-winter convention at New York City, Feb. 14-16.

American Institute of Mining and Metallurgical Engineers, 29 West 39th St., New York City. Annual meeting at New York City, Feb. 19-21.

To Honor Italian Ambassador

American engineers are planning a big reception to Prince Celasio Gaetani, Italian ambassador to Washington, who arrived in this country on Dec. 20. A dinner attended by engineers from all parts of the country will be tendered the new diplomat, himself an engineer, by the American Engineering Council of the F.A.E.S. in Washington on Jan. 12.

Mining engineers will be particularly active in welcoming Prince Gaetani, who, after his graduation in 1903 from the School of Mines of Columbia University, went west and made his mark in ore dressing, winning his way by sheer ability.

The dinner will be the concluding event of the two-day annual meeting of the Council, which will consider problems of national interest, including the report of the Committee on Work Periods in Continuous Industries, which has reported in favor of the eight-hour day. Dean Mortimer E. Cooley, of the University of Michigan, president of the Federation, will preside.

Industrial Activity Approaches 1919 Peak Level

The recovery of business in the United States since the severe depression late in 1920 and early in 1921 has been unusually rapid, and industrial activity today is fast approaching the level at the peak of the boom of 1919-1920, according to the ninth bi-monthly review of industrial-economic conditions in the United States, just issued by the National Industrial Conference Board. General business is probably not quite up to this point, but the situation is sound and far better than could have been reasonably expected at the beginning of 1921 or even at the beginning of 1922.

The most serious impediment to increasing business and further industrial activity is the car shortage, which has prevented those industries that ship in carload lots from attaining as large an output as they would otherwise have been able to effect. This condition is partly an echo of the railway shopmen's strike during the summer, but is more definitely a result of the tremendous volume of industrial and agricultural products which the railroads have been called upon to transport.

Labor shortage, particularly of the unskilled, has also handicapped some industries, and is considered an obstacle to any great increase in activity in the basic industries. The restrictions placed on immigration, together with the large outflow of emigrants are thought to have seriously affected the supply of labor and to have led to the prevailing upward movement of wages.

Two Boilers Explode in Havana

About a hundred workmen were killed and injured, it is reported, in a terrific boiler explosion on Dec. 11 at the Central Estrella, property of the Compañía Central Azucarera, an American syndicate situated near Havana, Cuba. Two of the boilers exploded, causing the complete destruction of a whole battery of boilers and the boiler house, the demolition of the engine house, and the wrecking of a large part of the main building. As far as can be ascertained the number of casualties is large, a great number of the workmen employed at the time having been buried by the falling walls and debris.

The Central Estrella was to have commenced grinding its crop for the coming season yesterday, everything being in readiness, with a full staff of workmen. Coming as it does at the beginning of the grinding season, the accident at Central Estrella will materially cut into Cuba's output of sugar. It is considered doubtful if the mill will be able to grind this season, and if it does start operations, the date is expected to be late. Another result of the tragedy will be the throwing of a large number of men out of work.

Mechanical Engineer Wanted for Civil Service

The United States Civil Service Commission has announced an examination for the position of associate mechanical engineer (internal-combustion engines) at $10.56 a day, to fill a vacancy in the Aëronautical Engineering Laboratory, Navy Yard. Washington, D. C.

The receipt of applications will close on Jan. 30. The duties of the appointee will be to act as technical advisor to the officer in charge and to take actual control of testing and designing work. Competitors will not be required to report for examination at any place, but will be rated on education, experience and fitness. Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or from the secretary of the Board of United States Civil Service Examiners at the post office or custom house of any city.

Water-Power Projects

A license of indeterminate length has been granted by the Federal Power Commission to the **Hydraulic Race Co.** of New York and the **Newsane Mill Owners Association,** involving a diversion of 500 second-feet through the state barge canal. The license will be revoked automatically in case the State of New York should revoke the permit allowing the use of the barge canal in the transportation of the water used in connection with the project.

A preliminary permit was awarded the **St. Croix Falls Improvement Co.,** a subsidiary of the Northern States Power Co., covering the development of power on the St. Croix River in Wisconsin. The conflicting applications of the **City of St. Paul** and of **Markham, Kelsey, and Druar** were denied.

The Commission approved the issuance of a preliminary permit to the **Southern California Edison Co.,** covering an extensive project on the headwaters of the San Joaquin River.

The application of the **Smith-Sanders Power Co.,** of Rogersville, Tenn., for a preliminary permit to cover a development on the Holston River was denied. The commission is of the opinion that the applicants are not in a position to make the best use of the power resources of the stream.

The commission has received an application from the **Pigeon River Lumber Co.,** of Wisconsin Rapids, Wis., for a preliminary permit for five power dams within fifteen miles just above the mouth of the Pigeon River, to develop approximately 40,000 hp.

The **Imboden Hydro-electric & Manufacturing Co.,** of Imboden, Ark., has applied for a license for a diversion dam, canal and power house in Spring River, near Imboden, Ark., to develop 2,400 hp. for public-utility use.

The City of Los Angeles has filed application to build a new municipal power house on the aqueduct at Haiwee Narrows, to develop 6,400 hp. The new plant will be one of a chain of similar water-power plants.

An application for a combined power and irrigation project at Placerville, Calif., has been filed with the Commission by **M. C. Seagrave.** The plant will develop 13,000 hp.

An acrimonious contest probably will be staged before the Federal Power Commission in regard to rights on the **Ouachiita River.** The **Caddo River Power and Irrigation Co.,** affiliated with the Arkansas Light and Power Co., holds a license authorizing the development of two sites, including a large storage reservoir, but this company is anxious to develop first a small site lower down on the Ouachita. It developed that the **Electric Bond and Share Co.** many years ago bought up property rights along this stream, expecting to develop power when the demand for it should justify the expenditure. Each side is known to be making careful preparations to fight for the site in controversy.

New Publications

Belt Conveyors and Belt Elevators. By Frederic V. Hetzel. Published by John Wiley & Sons, Inc., 432 Fourth Avenue, New York City. Cloth; 6x9 in.; 333 pages, including a thorough index of 13 pages. Price, $5.

This book contains practical information, based on a thirty years' experience in design, manufacture and operation of such conveying machinery and does not represent a mere restatement of material that has already appeared in trade advertisements or technical magazines. It is intended to explain principles and reasons for doing things, and to impart information required by men who deal with material handling, as well as those who design and operate conveyors. The author has been chief engineer for thirteen years of a large manufacturing company, and his experience extends over three-quarters of the time that such machinery has been in use, which is about forty years. He is qualified to speak from the viewpoint of designing and manufacturing, as well as dealing with suggestions and complaints from users and in co-operating with them in working out improvements. Belt conveyors are described in thirteen chapters occupying 206 pages, while belt elevators are given ten chapters and 114 pages. The general description of component parts of a belt conveyor is followed by chapters on individual parts, such as various kinds of belts, methods of driving the belts, tension and take-up devices, etc., all of which are treated in a direct and satisfactory manner, concluding with chapters on special uses and methods of using belt conveyors.

The second part, "Belt Elevators," is given a similar treatment. Design is touched upon where necessary, giving tables and formulas appropriate to the subject under discussion. As an encyclopedia of both practical and design information, well illustrated and rendered this book should fill the place of a standard work of reference in regard to such machinery, reflecting the experience and ability of the author.

Business Items

O. C. Keckley Co., Chicago, has appointed T. J. MacMaster as manager of its specialty department.

W. B. Connor, Inc., New York City, has appointed A. E. Jones, formerly with the Terry Steam Turbine Co., as sales engineer, to take effect Jan. 1.

The Ingersoll-Rand Co. and the **A. S. Cameron Steam Pump Works** have opened a branch office at 718 Ellicott Square Building, Buffalo, N. Y.

The Wilson Welder & Metals Co. is now represented in Maryland, Virginia and the District of Columbia by the Alexander Milburn Co. of Baltimore.

The United Machine & Mfg. Co., Canton, Ohio, has acquired controlling interest in the James A. Brady Foundry Co., Chicago. L. E. Griffith is now president of both organizations.

Charles E. Knox Associates, consulting electrical engineers, 101 Park Ave., New York City, will change the firm name on Jan. 1 to **Kaiser, Muller & Davies.**

Westinghouse Electric & Manufacturing Co. has placed E. F. Clark, formerly of Philadelphia, in charge of the marine sales department in New York City.

Warren Webster & Co., Camden, N. J., has opened a branch office in Los Angeles at 306 Crocker St., in charge

of R. M. Gunzel. The company's San Francisco office at 171 Second St. will be operated as a direct branch office, in charge of Paul W. Beggs.

The Bass Foundry & Machine Co., Fort Wayne, Ind., has appointed the Harold R. Wilson Machinery Co., St. Louis, Mo., with offices at 1101 Federal Reserve Bank Building, as its agent in the territory covering Missouri, Kansas, Oklahoma, Arkansas and southern Illinois.

The Nelson Valve Co., Chestnut Hill, Philadelphia, has elected a new vice-president and general manager—Howard E. Eddy, formerly with Manning, Maxwell & Moore, Inc. Other appointees are C. W. Brown, of Philadelphia, as secretary and treasurer; C. D. Miller, formerly with Manning, Maxwell & Moore, as works manager, and C. W. Burrage as mechanical engineer.

The McClave Brooks Co., Scranton, Pa., has announced the following changes in its sales organization, effective January 1: A. R. St. John, now of the New York office, will become manager of the Syracuse office. George Blair, Jr., manager of the Philadelphia office, will assume also the managership of the New York office, thus incorporating the New York and Philadelphia territories into one. D. G. Counts will become manager of the newly opened office in Memphis, Tenn., and will continue the managership of the Dallas office. R. R. Causey will be assistant to Mr. Counts in the Memphis-Dallas territory.

The Worthington Pump & Machinery Corp., New York City, has promoted E. T. Fishwick from sales manager to vice-president in charge of sales to succeed F. H. Jones, resigned vice-president. William Goodman, formerly assistant to J. E. Sague, vice-president, has succeeded the latter. James C. Barnaby, formerly plant engineer of the Staten Island Shipbuilding Co., is now in charge of engineering work in the Diesel oil engine division.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Dec. 11, 1922	Dec. 18, 1922
Pool 1,	New York	$5.00–5.50	$5.50–6.00
Smokeless,	Columbus	5.75–6.25	5.75–6.25
Clearfield,	Boston	3.25–4.00	3.50–4.85
Somerset,	Boston	3.50–4.25	3.75–4.50
Kanawha,	Columbus	3.00–3.50	2.90–3.10
Hocking,	Columbus	2.50–2.75	2.50–2.75
Pittsburgh No. 8	Cleveland	3.00–3.25	3.15–3.25
Franklin, Ill.,	Chicago	4.00–4.25	4.00–4.25
Central, Ill.,	Chicago	3.00–3.25	3.00–3.25
Ind. 4th Vein,	Chicago	3.75–4.00	3.75–4.00
West Ky.,	Louisville	2.00–2.50	2.00–2.50
Big Seam,	Birmingham	2.25–2.50	2.25–2.50
S. E. Ky.,	Louisville	3.00–3.75	3.00–3.75

FUEL OIL

New York—Dec. 21, Port Arthur light oil, 22@25 deg. Baumé, 4¼c. per gal.; 30@35 deg., 5¼c. per gal., f.o.b. Bayonne, N. J.

Chicago—Dec. 16, for 24@26 deg. Baumé, 90c. per bbl.; 32@36 deg., 2¼@3c. per gal. in tank car, f.o.b. Oklahoma refinery, or freight adjusted.

Philadelphia—Dec. 18, 26@28 deg. Baumé, Oklahoma, 90@95c. per bbl.; 30@34 deg., Oklahoma (group 3). 2⅝@2¾c. per gal.; 16@20 deg. Seaboard, $1.30@$1.40 per bbl.

St. Louis—Dec. 11, f.o.b. Oklahoma 24@26 deg., 95c. per bbl.; 26@28 deg., $1 per bbl.; 28@30 deg., $1.05 per bbl.; Gas oil 32@36 deg., 3c. per gal.; 36@40 deg., distillate, 3½@3¾c. per gal.

Pittsburgh—Dec. 6, f.o.b. refinery, Penn., 36@40 deg., 5½@5¾c. per gal.; Kentucky, 26@30 deg., 4c.; Diesel, 3¼c.; Gas oil, 32@.6 deg., 2½@2⅝c.; 36@38 deg., 2½@3c.; 38@40 deg., 2¾@3¼c. per gal.; Western, 24@30 deg., 90c.@$1.05 per bbl.

Cincinnati—Nov. 27, for 26@28 deg., Baumé, 1¼c. per gal.; 28@30 deg., Diesel, 5⅜c.; 38@40 deg., distillate, 6¼c. per gal.

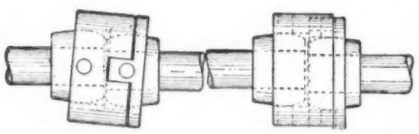
Cleveland—Nov. 27, for 26@28 deg., Baumé, 4⅜c. per gal.

Dallas—Dec. 16, 26@30 deg., $1.20 per bbl.

Condensed-Clipping Index of Equipment

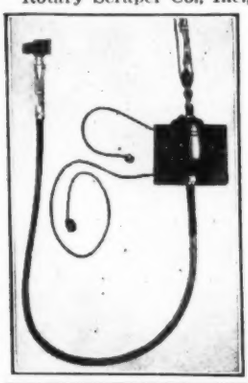
For quick reading and convenient filing.

Coupling, Bartlett Flexible "Power," 1922.
C. H. Breaker, 4226 Broadway, Indianapolis, Ind.



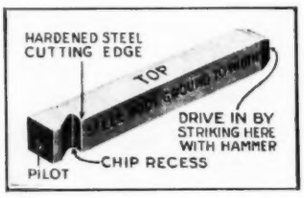
A flexible coupling for connecting two rotating shafts that may not be exactly in line, designed particularly to give uniform angular velocity ratio, to provide for a little end play and to allow of being taken apart readily. Two views of one coupling are illustrated here, one showing the device turned 90 degrees from the position in the other view. A rounded hub is keyed on the end of each shaft, and the two rings swivel on hardened pins that are driven into both sides of the hubs. The rings connect with each other through a tongue and groove, thus allowing for slight end play. The angle of mis-alignment may be allowed to reach 6 degrees, according to the manufacturer. It is said that couplings operating on this patented principle may be supplied to drive through any angle up to 90 degrees. The inventor of the device is G. M. Bartlett. Other types of couplings are made on the same principle.

Scraper, Rotary "Power," 1922.
Rotary Scraper Co., Inc., 39 Broadway, New York City



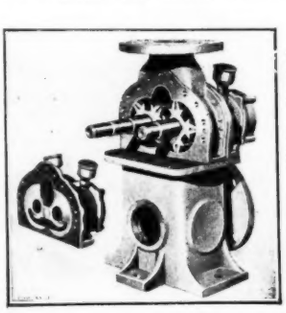
The principal use of this device is the removal of rust, paint and scale from metallic surfaces; it is claimed that it will perform such work with great thoroughness and with such speed as to replace ten or fifteen men with hand chipping hammers. It is also found useful for grinding, buffing, polishing, drilling, reaming, etc. It consists of a portable electric motor, a flexible shaft and a set of tools to be attached to the shaft. One of these tools (shown in the illustration) consists of twelve swinging hammers which, revolving at 3,500 or 4,000 r.p.m., are thrown against the surface to be cleaned with great speed and force. Other tools include a steel wire brush, an emery wheel and a buffing wheel. The machine complete weighs about 80 pounds.

Key, "Keytite Self-Fitting" "Power," 1922.
Smith & Serrell, Central Ave. at Halsey St., Newark, N. J.



A key designed to do away with the careful and time-consuming hand fitting usually necessary to insure a tight fit between key and keyway. It is provided with a cutting edge and chip recess on one side (on both sides in the large sizes), and as it is driven home in the rough keyway it cuts a chip from the side wall, thus sizing the keyway to make a tight fit between body of key and keyway. The key is made of a tough chisel stock.

Pump, Rotary "Power," 1922.
Northern Fire Apparatus Co., Minneapolis, Minn.



An improved gear pump designed primarily for fire fighting, but adaptable to industrial uses, pumping water, oil or other liquids. It is made in capacities of from 26 to 1,000 gal. per min., at speeds ranging from 300 to 1,800 r.p.m., and at maximum pressures ranging from 125 to 700 or more pounds per square inch. A feature is the so-called lateral intake and discharge; the water is drawn in at the ends of the impeller teeth, not radially, and is discharged both radially and at the ends, thus giving a smoother flow for the water and preventing water friction. Leakage is prevented and wear is taken up by packing strips that are held in slots in the gear teeth and that are pressed against the cylinder walls by light bronze springs.

For a permanent file of new and improved power-plant equipment, clip and paste on 3 x 5-in. cards. (Patented Aug. 20, 1918.)

New Plant Construction

POWER PROPOSED

Calif., Bigpine—G. B. Warren plans the irrigation of 640 acres of land, involving 3½ mi. canal, small dam to store 360 ac.ft. and pumping plant to lift stored water to high land.

Calif., Fresno—The Fraternal Order of Eagles, Aerie No. 39, M. P. Hall, Treas., building association, 921 Terrace St., plans the construction of a 6 story, lodge, club and office building, on M and Fresno Sts. Estimated cost $500,000. Architect not selected.

Calif., Los Angeles—A. C. Blumenthal, et al., Loew State Bldg., plans the construction of two 12 story office buildings on Mercantile Pl. Estimated cost $2,000,000. S. Schnaittacher, 233 Post St., San Francisco, Archt.

Calif., Los Angeles—The Union Pacific R.R. Co., 15th and Dodge Sts., Omaha, Neb., will soon receive bids for the construction of railroad shops, including engine house, locomotive shop and a coach and car shop here. Estimated cost $1,500,000 to $2,000,000. R. L. Huntley, Omaha, Neb., Ch. Engr.

Calif., Sacramento—L. Glide, c/o J. Morgan, Archt., Merchants Exchange Bldg., San Francisco, is having plans prepared for the construction of a 2 story, 160 x 170 ft. market building on 13th and J Sts. Estimated cost $200,000. Equipment detail not reported.

Calif., San Francisco—The city and county of San Francisco received bids for electric traveling crane for the Moccasin Creek power plant Hetch Hetchy project from Pawling & Harnischfeger Co., 32 Beale St., $30,475; Cyclop Iron Works, 837 Folsom St., $32,170, alternate bid $27,670; Pratt & Whitney, 16 Fremont St., $33,050.

Calif., San Francisco—The Medical Center Corp., Dr. G. S. Millberry, Secy., 1041 Clayton St., plans the construction of a 10 story, 137 x 137 ft. medical office building and garage on Mason and Post Sts. Estimated cost $1,250,000. Architect not selected.

Conn., New Haven—The New Haven Gas Light Co., 80 Crown St., plans the construction of a boiler house on Chapel St. Estimated cost $25,000. Westcott & Mapes, Inc., 207 Orange St., Archts. and Engrs.

Ill., Chicago—Holabird & Roche, Archts., 104 South Michigan Ave., are receiving bids for a 5 story, 100 x 135 ft. addition to office building on La Salle and Madison Sts., for L. J. McCornick, c/o Archts. Estimated cost $500,000. Equipment detail not reported.

Ill., Chicago—Holabird & Roche, Archts., 104 South Michigan Ave., will receive bids until Feb. 1, 1923, for a 25 story, 173 x 402 ft. hotel "Stevens," including steam heating system on Michigan Blvd., for J. W. and E. J. Stevens, c/o La Salle Hotel. Estimated cost $15,000,000. Noted Oct. 14.

Ill., Chicago—The Sacred Heart Congregation, 7021 South May St., is having plans prepared for the construction of a 5 story, 50 x 140 ft. school, convent and church on 70th and South May Sts. Estimated cost $500,000. Comes, Perry & McMullen, Renshaw Bldg., Pittsburgh, Pa., Archts. Equipment detail not reported.

Ill., East St. Louis—H. Redmond et al., Collinsville Ave., is having preliminary plans prepared for the construction of an 8 story, 132 x 175 ft. theatre and office building or hotel, on present site. Estimated cost $750,000. Riester & Rubach, Murphy Bldg., Archts.

Ill., Granite City—The Madison County Light & Power Co., is in the market for transmission lines and substation equipment. Estimated cost $50,000.

Ind., Cannelton—The Cannelton Sewer Pipe Co., plans the construction of a 4 story, 62 x 208 ft. clay plant including 8 kilns, 120 ft. radial stack, power plant and 1,000 ft. additional switching facilities. Estimated cost $240,000. Private plans.

Ind., Huntington—J. F. Bippers, 841 North Jefferson St., is having plans prepared for the construction of an 8 story, 133 x 144 ft. hotel. Estimated cost $500,000. Private plans. Equipment detail not reported.

Ia., Knoxville—The U. S. Veterans' Bureau, Quartermaster General's Office, 2306 Munitions Bldg., Wash., D. C., received bids for the construction of a U. S. Veterans' Hospital, here, including mechanical equipment, from the Warner Constr. Co., 730 Waveland Ave., Chicago, Ill., $889,974, (240 days;) W. D. Lovell, 1415 8th St., SE. Minneapolis, Minn., $859,400 (375 days;) W. Kuucharo & Co., 622 Hubbell Bldg., Des Moines, $928,800 (365 days.) Noted Nov. 21.

Ia., Van Horn—The city is having plans prepared for new waterworks system including pump house, equipment, 50,000 gal. tank on 100 ft. tower, 2 mi. c.i. water mains and 30 fire hydrants. Estimated cost $35,000. Howard R. Green Co., 634 Cedar Rapids Bank Bldg., Cedar Rapids, Engrs.

Ky., Ormsby (Lakeland P. O.)—A. Loomis, Archt., 31 Todd Bldg., Louisville, is preparing plans for the construction of a group of 30 buildings for the Louisville and Jefferson County Home here. Estimated cost $1,000,000.

Mich., Ann Arbor—The Alumnae of University of Michigan is having plans prepared for the construction of an alumnae building. Estimated cost $1,000,000. York & Sawyer, 50 East 41st St., New York, Archts. Equipment detail not reported.

Mich., Detroit—The Public Lighting Comn., 138 East Atwater St., F. Bowler, Secy., will receive bids until Jan. 8, 1923, for furnishing machinery and equipment, including boilers, stokers, powdered coal equipment, superheaters, economizers, turbines, generators and condensers for new power plant. Received bids for the construction of a 56 x 83 ft. electric substation on Woodward Ave., from Corrick Bros., Owen Bldg., $54,989; Max Bartholomaei Sons & Co., 1574 East Warren Ave., $57,106; Brayton Engr. Co., 907 Kresge Bldg., $57,151. Smith, Hinchman & Grylls, 800 Marquette Bldg., Engrs. Noted Oct. 10.

Mich., River Rouge — A. Kahn, Engr., 1000 Marquette Bldg., Detroit, will receive bids until Dec. 29 for the construction of a 150 x 300 ft. wet process plant for making portland cement, for the Ford Motor Co., Highland Park, Detroit. Equipment includes coal grinding mills, 18 in. stocking conveyors, 2 reclaiming conveyors, slurry pump, rotary coolers, etc. Pulverized coal burning equipment, a waste heat boiler, motors and wiring for operating machinery will be installed.

Minn., Ely—The Bd. Educ., H. J. Lockhart, Clk., plans the construction of a 3 story high school, including steam heating spstem, etc. Estimated cost $600,000. Architect not announced.

Minn., Minneapolis—The Zuhrah Temple Assn., c/o A. A. D. Rahn, 616 Masonic Temple, is having plans prepared for the construction of a 4 story, 206 x 257 x 237 ft. shrine temple, including steam heating system, etc., on Erie St. and Hennepin Ave. Estimated cost $1,000,000. Bertrand & Chamberlin, 616 Northwestern Bank Bldg., Archts.

Minn., Winona—The city is having plans prepared for new pumping station, including 3 steam driven air compressors, air lift equivalent for 4 deep wells, also 2,000,000 gal. reservoir. Noted Aug. 1.

Minn., Winona—The State Bd. of Control, D. F. Mullin, Secy., Capitol, St. Paul, plans the construction of a 4 story, main building, including steam heating system, etc., for the State Teachers' College, here, to replace building recently destroyed by fire. Estimated cost $500,000. C. H. Johnston, 715 Capital Bank Bldg., St. Paul, Archt.

Mo., St. Louis—A. A. Wagner, 5628 Delmar Blvd., has purchased site and plans the construction of a 7 story, 80 x 200 ft. apartment building on Clara Ave. Estimated cost $500,000. J. P. Cravens, Chemical Bldg., Archt.

Mont., Butte—The New Finlen Hotel Co., c/o J. Finlen, Finlen Hotel, will receive bids until Dec. 28 for the construction of a 9 story hotel, including steam heating system, etc. Estimated cost $700,000. Shanley-Baker, Great Falls, Archts. Equipment detail not reported.

N. Y., Angola—L. L. Brown is in the market for ice manufacturing machinery.

N. Y., Brooklyn — The Bd. Educ., 500 Park Ave., New York, will soon receive bids for the construction of a school building, P. S. No. 201, including steam heating system, on 80th St. and 12th Ave., here. Estimated cost $500,000. C. B. J. Snyder, Flatbush Ave. Extension and Concord Sts., Brooklyn, Archts.

N. Y., Brooklyn—The Brooklyn Edison Co., 360 Pearl St., will soon receive bids for the construction of a power plant on Marshall St., initial capacity 2 units, 50,000 kw. each, ultimate total capacity 400,000 kw. Estimated cost $10,000,000. T. E. Murray, Inc., 55 Duane St., New York, Archt. G. L. Knight, 360 Pearl St., Bklyn., Engr. Noted Aug. 29.

N. Y., New York—The Manhattan Eye & Ear Hospital, 208 East 64th St., is having preliminary plans prepared for the construction of addition and alterations to hospital. Estimated cost $300,000. York & Sawyer, 506 East 41st St., Archts. and Engrs.

Ohio, Akron—The United Cigar Stores Co., 44 West 18th St., New York, will soon receive bids for the construction of an 8 story, 58 x 100 ft. office building on Main and Market Sts., here. Estimated cost $800,000. J. Gehres, 336 Akron Savings and Loan Co., Akron, Engr. Sommerfeld & Stechler, 31 Union Square, New York, Archts. Equipment detail not reported.

Ohio, Cleveland—The Bd. Educ., F. G. Hogan, Dir., is having plans prepared for the construction of a 3 story, 40 room John Hay School of Commerce on East 107th St. and Fairchild Ave.; also plans 3 story, 22 room elementary school, including steam heating system, on East 176th St. and Groveland Ave. Estimated cost $1,500,000 and $400,000 respectively. W. R. McCornack, East 6th St. and Rockwell Ave., Archt. Noted Nov. 28.

Ohio, Cleveland—The Comr. of Purchases, City Hall, is in the market for 2 steam turbine reduction gear driven forced draught fans, 2 steam turbine driven centrifugal boiler feed pumps, 1 hydraulic driven centrifugal boiler feed pump, 4 hydraulic turbine stoker drives for the Fairmount Pumping Station.

Ohio, Columbus—The Union Oil-Cloth Co., 7th Ave. and Big Four Tracks, R. H. Wilcox, Purch. Agt., is in the market for large generator set and special oil cloth machinery.

Ohio, Sandusky—The Ajax Rubber Co., 220 West 57th St., New York, is having plans prepared for the construction of a 6 story tire manufacturing plant, here. Estimated cost $1,000,000. S. M. Green Co., 293 Bridge St., Springfield, Mass., Engr.

Okla., Sand Springs—The Sand Springs Power, Light & Water Co., plans to double the capacity of its power plant, 15,000 kw.

Okla., Wynne Wood—The city will vote on a $50,300 bond issue Dec. 28, for the construction of a new tank, tower, mains, pumping equipment and reservoir. V. V. Long & Co., 1300 Colcord St., Oklahoma City, Engrs.

Ore., Scappoose—The Scappoose Drainage Dist., E. E. Wist, Pres., plans the drainage of 5,000 acres of Columbia River overflow land in Columbia County, which will consist of clearing right of way for dykes, building dykes, tide gates and canals and installing electrically operated pumps, may generate own electricity or connect with power lines. Estimated cost $200,000. Barr & Cunningham, Spalding Bldg., Portland, Engrs.

Pa., Phila.—The city will receive bids until Dec. 29 for furnishing and installing coal handling equipment, including locomotive crane, tractor, steel cars, etc., also turbo centrifugal pump 250 g.p.m. capacity, 2,500 r.p.m., etc., fire hydrants, valves, c.i. pipe, etc., for the city pumping station. Noted May 16. C. E. Davis, City Hall, Engr.

Pa., Phila.—H. Trumbauer, Archt., Land Title Bldg., is receiving bids for the construction of a 16 story, 194 x 230 ft. hotel on 9th and Chestnut Sts. for the Benj. Franklin Hotel Co., c/o A. H. Mershon. Estimated cost $1,500,000. Equipment detail not reported. Noted July 25.

Pa., Pittsburgh—The Bd. Educ., Fulton Bldg., J. W. Bonar, Supt. of Constr., is in the market for ash handling equipment.

Pa., Scranton—The Susquehanna Light & Power Co., plans to issue $100,000 bonds for extensions and improvements to lines and system.

S. C., Florence—The Palmetto Light & Power Co., plans to issue $35,000 bonds for extensions and improvements to its lines and plant. Owner is in the market for additional equipment for plant. Noted June 20.

Tex., Dallas—Lang & Witchell, Archts., 300 American Exchange Nat. Bank Bldg., will receive bids until Jan. 15, 1923, for the

construction of a 12 story club building, for the Dallas Athletic Club. Estimated cost $1,250,000. Equipment detail not reported.

Tex., Fort Worth—The Alfred Ice Co., Jasemine and Jennings Sts., is in the market for $45,000 worth of ice machinery.

Tex., Groesbeck—Limestone County, F. Kirby, Judge, plans the construction of a court house on Ellis St. Estimated cost $500,000. Architect not selected.

Tex., Henderson—E. L. Hightower is in the market for a 150 hp. Y type Fairbank engine for machine shop.

Tex., Henderson—The Henderson Cotton Oil & Gin Co. is in the market for a 60 hp., 2,200 volt, 60 cycle, 900 r.p.m. motor.

Tex., Houston—The Houston Cotton Exchange is having plans prepared for the construction of a 16 story board of trade, cotton exchange building on Prairie and Caroline Sts. Estimated cost $1,000,000. Sanguinet, Staats & Gottlieb, Carter Bldg., Engrs. and Archts. Equipment detail not reported.

Tex., Houston—J. Jones, Goggan Bldg., is having preliminary plans prepared for the construction of a 12 story, 150 x 200 ft. apartment building. Estimated cost $1,500,000. Architect not selected.

Tex., Port Arthur—The Bd. Educ. is having plans prepared for the construction of an 80 x 232 ft. addition to grade school consisting of gymnasium, auditorium, manual training shops, etc., including 2 boiler steam plant, fan ventilation system, boilers to be fired by oil, estimated cost $150,000; also having plans prepared for 2 wings each 145 x 160 ft. and a 30 x 65 ft. boiler house for the Manual Training and Commercial high school on Lake Shore Blvd. Estimated cost each wing $200,000, boiler house $100,000. W. B. Ittner, Room 428, 911 Locust St., St. Louis, Mo., Archt.

Va., Richmond — The Hackley Morrison Co., Inc., 1708 Lewis St., G. W. Booth, Purch. Agt., is in the market for 250 hp. scotch marine and 20 hp. vertical boilers, 100 ton track scale standard guage, ¾ yd. caterpillar tread steam shovel, two 52 x 16 x 3 7/16 in. cast split pulleys, extra heavy, with key way and set screws.

Va., Wytheville—R. P. Johnson, O. M. Johnson, Purch. Agt., is in the market for 100 hp. HRT boiler, not less than 100 lbs. pressure, completely equipped including smokestack; 30 to 40 ton, 42 in. guage geared locomotive, ¾ yd. steam shovel caterpillar tread, new; portable gasoline engine drive air compressor outfit about 100 cu.ft. free air per min., 25 to 40 hp. crude oil engine complete, 75 hp. steam engine complete, etc. (used).

W. Va., Bluefield—The city will receive bids about Jan. 1, 1923, for a 2,000,000 gal. capacity filtration plant, including turbo centrifugal pump. Estimated cost $75,000. Alvord, Burdick & Howson, 8 South Dearborn St., Chicago, Ill., Engrs.

W. Va., Fairmont — The Imperial Ice Cream Co., Clarksburg, is having plans prepared for the construction of a 1 story, 50 x 120 ft. ice cream factory, including 15 ton ice plant, on 5th St. and Virginia Ave., here. Estimated cost $15,000.

W. Va., Parkersburg — The Blackwood Electric Steel Corp. is in the market for annealing furnaces, traveling crane, electric welders, air compressors, acetylene generators and grinders.

Wis., Fond du Lac—The Water Dept., J. J. Breidster, Supt., plans to purchase steam driven pump about 5,000 to 10,000 gal. per day capacity, boiler, a quantity of c.i. water-mains and service connections. Estimated cost $50,000. G. H. Stanchfield, City Hall, Engr.

Wis., Madison—Piper Brothers, 31 North Pinckney St., is in the market for refrigeration machinery.

Wis., Madison—M. Sommers, 512 West Wilson St., is in the market for refrigeration machinery.

Wis., Racine—B. R. Adams, 1010 13th St., is in the market for ice making machinery, about 40 ton capacity, for dairy.

Wis., Racine—The New Racine Hotel Co. and W. E. Perry and Fugard & Knapp, Archts., 212 East Superior St., Chicago, Ill., received bids for the first unit of a 7 and 8 story, 100 x 120 ft. hotel on 6th and Main Sts., here. Estimated cost $600,000. All bids rejected, will be readvertised. Noted Aug. 29.

Wis., Rhinelander—The S. Miller Cold Storage Co., S. Miller, Pres., Marshfield, plans the construction of a 3 story, 44 x 120 ft. cold storage plant, here. Estimated cost $150,000. Architect not selected.

Wis., West Allis—The Gas Tank Recharging Co., 1245 23rd Ave., Milwaukee, is receiving bids for the construction of a 1 story manufacturing plant, consisting of a 41 x 81 ft. carbide building, a 20 x 29 ft. boiler house, a 41 x 81 ft, purifying, etc., building, a 41 x 81 ft. shipping and storage building and a 41 x 100 ft. recharging building, here. O. C. Randolph, 53 West Jackson Blvd., Chicago, Ill., Engr.

N. B., St. John—The Civic Hydro Comn., H. Phillips, Secy., recommends making plans for the construction and equipment of a substation for electric distribution. Estimated cost $80,000. Noted Dec. 7.

Ont., Arnprior—E. McKinney is in the market for cold storage and refrigeration machinery and equipment.

Ont., Goderich—The council plans the construction of several deep wells and the installation of an electric centrifugal pump. T. R. Patterson, Town Hall, Engr.

Ont., Niagara Falls—The township of Stamford, T. R. Stokes, Clk., Niagara Falls, plans to extend hydro-electric power lines throughout the township. Estimated cost $38,000.

Ont., Port Arthur — The Port Arthur Pub. Utilities Comn. has requested the Hydro Electric Comn. of Ont., University Ave., Toronto, to install another unit in the Cameron Falls power plant on the Nipegon River, present turbines (2) are Francis single runner, vertical 120 r.p.m. each 12,500 hp. direct connected to 10,600 kva. vertical generators, operating at 12,000 volts, head 78 ft. F. A. Gaby, Ch. Engr.

Que., Montreal—The Back River Power Co., J. R. Walker, Pres., is having plans prepared for a 50,000 hp. development on the Riviere des Prairies below Visitation Island, a dam will be built from Cheval de Terre Island to opposite St. Vincent de Paul, a head of 25 ft. will be maintained. Estimated cost $2,000,000. J. Pringle & Son, Coristine Bldg., Engrs.

Cuba, Guantamo—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., plans to install distilling apparatus and heaters, here. Estimated cost $35,000. Spec. 4769.

H. T., Pearl Harbor—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., plans to install refrigerating machinery at the Marine Base, here. Estimated cost $2,400. Spec. 4767.

Every one of these items is reported by our authorized correspondents who are instructed to verify every item sent in. This free weekly service is published in the interests of the buyer and the seller, to bring them together and get machinery moving.
Everything possible is done to insure authenticity and timeliness.
Your co-operation is invited in helping us maintain this service at the highest efficiency.

BUSINESS NEWS DEPARTMENT
Tenth Ave. at 36th St., New York

CONTRACTS AWARDED

Conn., Stamford—The Harris Constr. Co., 352 Atlantic St., has been awarded the contract for the construction of a 5 story apartment building on Rippowam Pl. and South St. Estimated cost $1,000,000. Heating and ventilating systems will be installed. Owner's name withheld.

Ia., Dubuque—T. J. Mulgrew, Jones & Iowa Sts., awarded the contract for the superstructure of an artificial ice and cold storage plant to the James Gregory Constr. Co., 1120 Iowa St. Estimated total cost $75,000.

La., Baton Rouge—The Bd. of Regents of the Louisiana State University awarded the contract for the construction of a power plant and engineering shops for the new Greater Agricultural College, to Estes, Williams & Ragsdale, Scimitar Bldg., Memphis, Tenn., $147,158. Noted Dec. 19.

Mass., Lynn—The Lynn Shore, Inc., c/o Seibert & Young, Archts., 177 State St., Boston, awarded the contract for the construction of a 6 story, 785 room hotel on Lynn Shore Blvd., to the Boyle Robertson Constr. Co., Evans Bldg., Wash., D. C., $1,850,000. Bids will be received later for the construction of a garage in connection with above hotel. Equipment detail not reported.

Mich., River Rouge—The Ford Motor Co., Highland Park, awarded the contract for the construction of a 260 x 365 ft. plate glass and gas producer plants, here, to E. Winters, 752 Book Bldg., Detroit, Mich. Estimated cost $1,500,000. Equipment detail not reported.

Mo., Kansas City—The Stats Hotel Co., c/o S. T. Stats, Plaza Hotel, awarded the contract for a 10 story, 50 x 142 ft. hotel on 12th and Wyandotte Sts., to the Mosby-Goodrich Constr. Co., 902 New York Life Bldg., $290,000; heating and plumbing, Arthur McKinley Plumbing & Heating Co., 1012 Troost St., $68,000. Noted Sept. 19.

Mo., St. Louis—The City Club, 911 Locust St., awarded the contract for the construction of a 12 story, 60 x 122 ft. club, office and stores building on Locust St., to the Humes-Deal Co., Century Bldg. Estimated cost $700,000. Complete heating system, two pipe method, will be installed. Noted Oct. 10.

N. J., Ocean City—The Ocean Front Hotel Co., c/o J. H. Slocum, awarded the contract for the superstructure of a 9 story, 230 room hotel, on the beach front to the Roydhouse-Arey Co., 112 North Broad St., Phila., Pa. $500,000. Equipment detail not reported. Noted Nov. 28.

N. Y., Lake Placid—The Lake Placid Club awarded the contract for the construction of 6 story, 44 x 210 ft. hotel addition and 3 story, 34 x 40 ft. and 4 story, 20 x 31 ft. buildings, to the Turner Constr. Co., 244 Madison Ave., New York. Equipment detail not reported.

N. Y., New York—H. Kornblum, 26 Court St., Bklyn., will build a 4 story, 45 x 135 ft. hotel on Joralemon and Clinton Sts., by separate contracts. Estimated cost $350,000. Private plans. Equipment detail not reported.

N. Y., New York—N. C. Partos, 1350 Bway, awarded the contract for the construction of a 20 story addition to office building on 35th St. and Bway. to the Fleischman Constr. Co., 531 7th Ave. Estimated cost $1,500,000. Equipment detail not reported.

Ohio, Cleveland—The Bd. Educ., East 6th St. and Rockwell Ave., F. G. Hogen, Dir., awarded the contract for the construction of a 2 story, 40 room Junior High school on West 46th St. and Hyde Ave., to J. F. Hohloch, Davis & Farley Bldg. Estimated cost $800,000. Equipment detail not reported. Noted Dec. 19.

Ohio, Dayton—The Dayton Power & Light Co., South Jefferson St., awarded the contract for the construction of a 4 story, 150 x 182 ft. service building on Monument St., to the U. S. Structural Co., Hartford St., $300,000.

Va., Cape Henry—The U. S. Engineer's Office, Norfolk, awarded the contract for the construction of 2 power houses at Fort Story, to H. M. Lucas, Maple Ave., Portsmouth, Va., $28,907. Noted Nov. 14.

Wash., Seattle—The Bd. of Pub. Wks., awarded the contract for the superstructure of the West Spokane Street Bridge as follows: furnishing steel and delivering at site, to the Bethlehem Ship Building Corp, Lyd., Morris Bldg., $276,871; erecting steel to the Gerreck & Gerreck Co., Central Bldg., $106,151; furnishing electrical equipment, Westinghouse Elec. & Mfg. Co., Alaska Bldg., $23,295. Noted Dec. 19.

Wash., Seattle—St. Vincent's Home for the Aged awarded the contract for the construction of a 5 story, 276 x 294 ft. institutional building on 35th S.W. and West Edmunds Sts. to H. Pederson, Alaska Bldg., about $1,000,000. Equipment detail not reported. Noted Nov. 28.

Wis., Delavan—The State Bd. of Control, M. J. Tappens, Secy., awarded the contract for a motor generator set for the State Normal School for Deaf, to H. Andrae Elec. Co., 136 2nd St. and Grand Ave., Milwaukee. Noted Nov. 21.

Wis., Madison—The University of Wisconsin, J. D. Phillips, Mgr., awarded the contract for the construction of a 4 story, 62 x 68 ft. service station, including garage, electric substation, woodworking shop, etc., to J. H. Findorff, 601 West Wilson St., $78,987.

Wis., Milwaukee — The Dept. of Pub. Wks., R. E. Stoeling, Comr., awarded the contract for furnishing and installing boilers in the Riverside pumping station at the foot of Chambers St., to the Industrial Heating & Engr. Co., 143 Oneida St., $68,500. Noted Oct. 31.

Volume 56 December 26, 1922 Number 26

POWER

FRED R. LOW, *Editor*

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PUMPS DESIGNED TO OPERATE against the unusually high head of 293 lb. per sq.in. maintain high efficiency over a wide range of operating conditions; translated to power-plant standards, the duty obtained is equivalent to production of a kilowatt-hour at the switchboard on 16,600 B.t.u.

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Moments with the Ad Editor

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Wishes You
a
Very
Merry
Christmas

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We have on record from one of our customers a letter which says they used Keystone Grease from a single barrel for over twenty-eight years and it proved in every respect during all this time a most excellent lubricant—they used no other grease in the meantime. Twenty-eight years old and as good as ever is the record of

KEYSTONE GREASE

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and obviously it must have been pretty good grease at the start. Incidentally the same record speaks well for the economy of its use. The absence of all animal and vegetable matter from Keystone Grease is one of the big reasons why its effectiveness is unchanged by age.

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"Chief" Ainsworth of the manufacturing building at 57 and 59 Prince St., New York City, pointed out these two Standard Iron Body Jenkins Globe Valves on main steam lines.

It is the original installation, and the valves have never been removed from the line. They have been actually working practically every day since this power plant was equipped in 1886.

It is typical of the enduring qualities of Jenkins Valves.

For *real* efficiency and economy, engineers are standardizing on Jenkins "Diamond" Valves.

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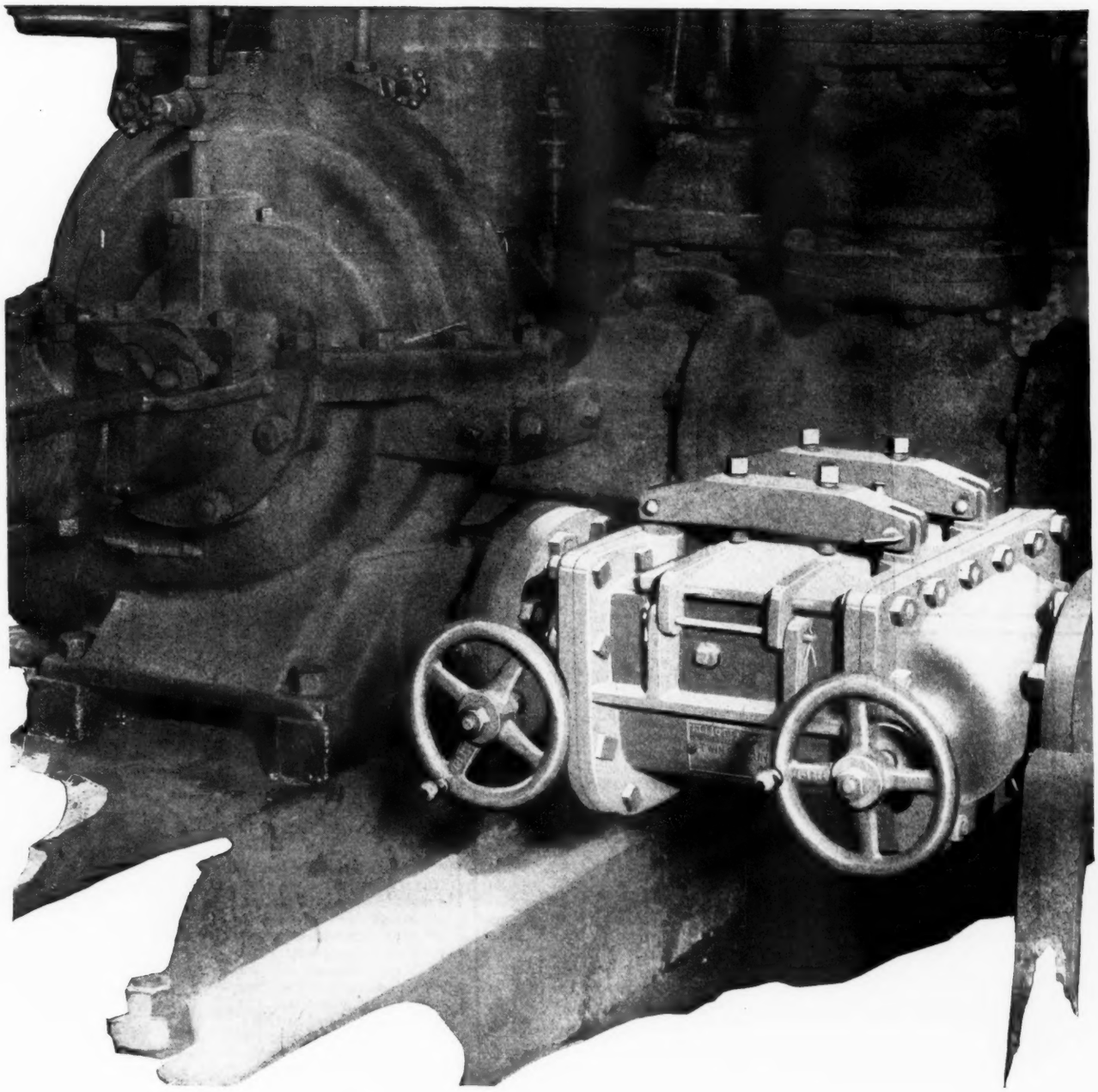

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Twin Strainers do it at minimum expense. Their twin construction means uninterrupted service. They may be installed in any position, vertical, horizontal, or on an angle. They can be connected directly to a pump or condenser, or in larger sizes in the main supply line. They are extremely accessible, compact and effective. Built in sizes from 2 in to 42 in., with straining mesh to suit the service.

A-88

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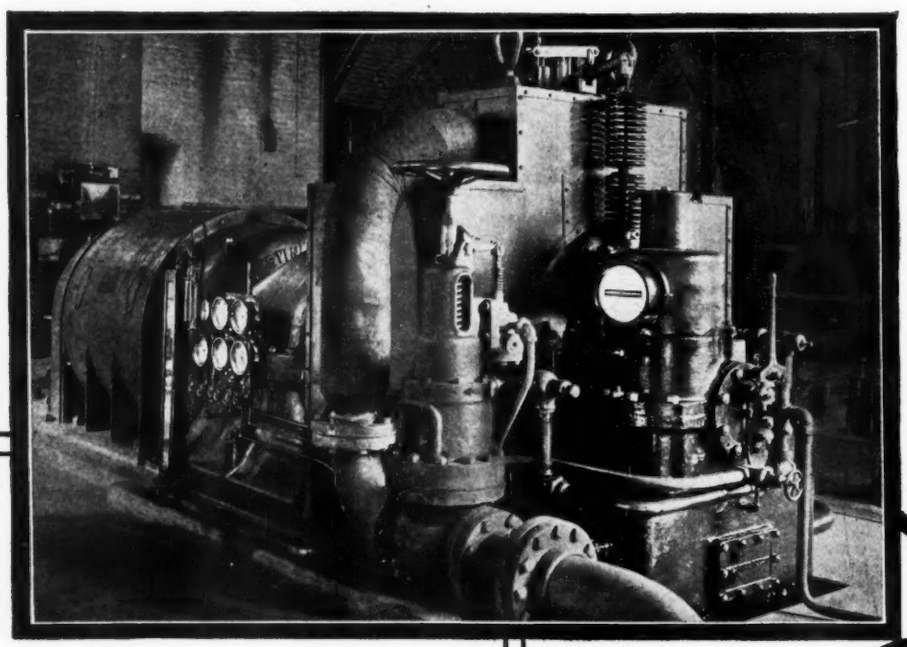
Pittsburgh, Pa.
GENERAL SALES OFFICES: JEANNETTE, PA.
District Sales and Service Offices in Principal Cities

Westinghouse Turbine Generators



A 1,000 kw. Westinghouse Turbine-Generator; 3-phase, 60-cycle, 480-volt; served by a Westinghouse Surface Condenser. Installed in the plant of the Wilkes-Barre Lace Mfg. Co., Wilkes-Barre, Pa.

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The power user appreciates that a commercial transaction, such as the purchasing of power generating apparatus, is satisfactory only when the service which precedes the sale continues until every operating condition and requirement is fully met.

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COPES Boiler Feed Regulator

feeds more intelligently than a careful man can!

It is impossible for even the best of hand-feeders to follow every change in water level and instantly do the right thing—increasing the feed or cutting it down, according to the scientific principles that have been worked out through lifelong study of boiler feed water regulation.

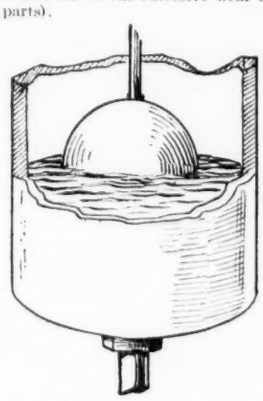
But the COPES Regulator does exactly that—watches every move of the true water level and instantly does the right thing—*automatically.*

The COPES increases feed when the load suddenly drops, thus storing the excess furnace heat. The COPES reduces the water input over every sudden peak, so that the stored heat can be used.

Sticks Closer to True Water Level Than a Float Can!

The COPES feeds correctly even on flash type boilers, in which the water is subject to violent momentary surges.

Under these conditions any feed water regulator depending on the rise and fall of a float would dance wildly up and down with the boiling hump in the boiler, giving uncertain regulation (with expensive repairs and a very short life, due to the excessive wear on all parts).



The COPES responds instantly—without lag—to changes in the true water level. But it is not affected by the sudden momentary changes which produce an apparent level without actual change in water volume.

Leading power plant engineers use the COPES Regulator because its variable-level feeding of the boiler saves fuel, and increases boiler efficiency. As one COPES user puts it:

"Equip six boilers with the COPES, and put a flow meter on the boilers and put a wattmeter on the units which these boilers supply. Then take six boilers without COPES Regulators, and the comparison will show a material saving in the cost of producing power."—A. L. Penniman, Supt. of Steam Stations, Cons. Gas Elec. Lt. & Pwr. Co.

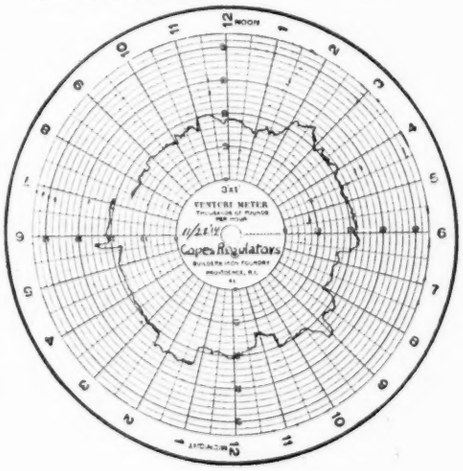
The COPES does its work practically without attention. There is almost nothing to wear out—no parts to need frequent adjustment or renewal. The COPES has no springs or diaphrams; no floats or displacement bodies. Nothing but a heavy metallic expansion tube which controls the opening of a perfectly balanced valve, according to changes in water level in the boiler.

In a report to the Garfield Fuel Administration, W. P. Frey, Fuel Engineer of the Lehigh Coal & Navigation Co., said:

"Automatic feed water regulation is so cheap, that it is the best boiler appliance that can be gotten for its worth in money."

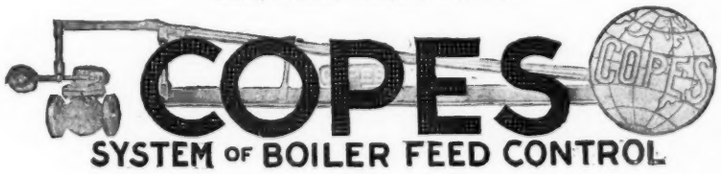
We welcome investigation, and will be very glad to send you full details. Nearly 10,000,000 boiler hp. are already equipped with the COPES. Over 98% of the largest central stations have chosen the COPES Regulator for feeding their boilers. *Write for our new Catalog A.*

This typical chart shows the smooth feeding that you get from Copes Regulation. Compare with charts obtained from hand feeding, or float type regulation.

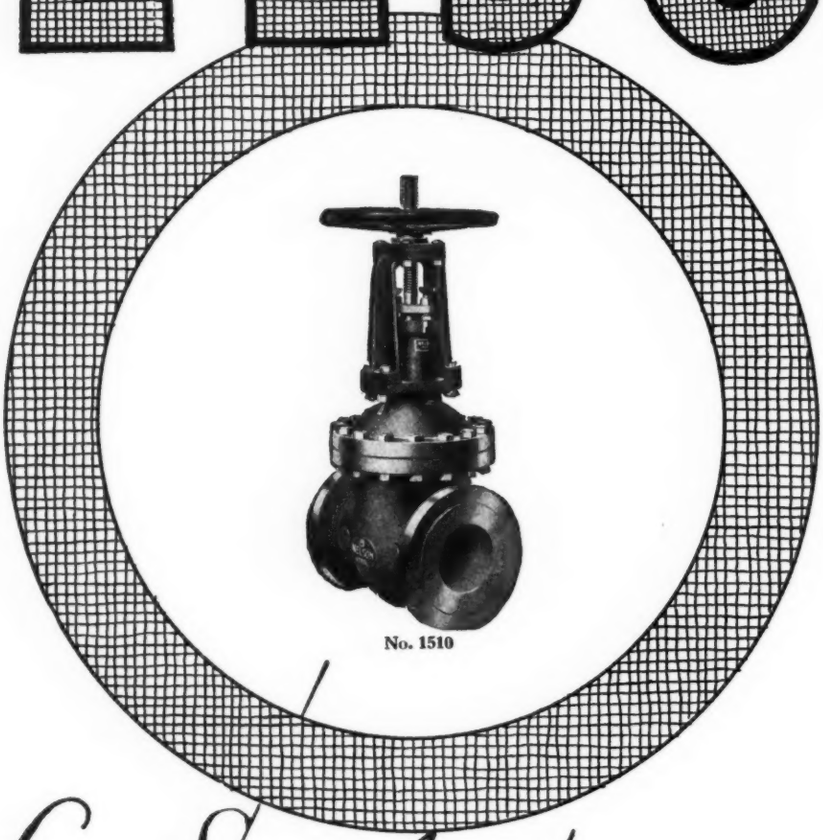


NORTHERN EQUIPMENT COMPANY, 110 W. 11th St., Erie, Pa.

Branch Plants: **Hamilton, Ontario, Canada; Croydon, England; Paris, France; Cologne, Germany.**



NELSON



No. 1510

for Superheat

assurance for the Plant Designer and Plant Operator

Because a valve is sturdily constructed and meets the preliminary tests in order to carry high pressures at high temperatures, it should not be taken for granted that it will give long, uninterrupted service.

This can only be obtained by construction which insures tight seating of the valve parts.

In numerous installations all over the world Nelson solid wedge taper-seat steel gate valves have thoroughly demonstrated their reliability and service qualities under most trying conditions. There is a Nelson Valve user in or near practically every large community and we would be glad to send you his name so that you can get first hand information on the value of Nelson Valves in actual service.

Send for folders describing Nelson Steel Valves for superheated steam service.

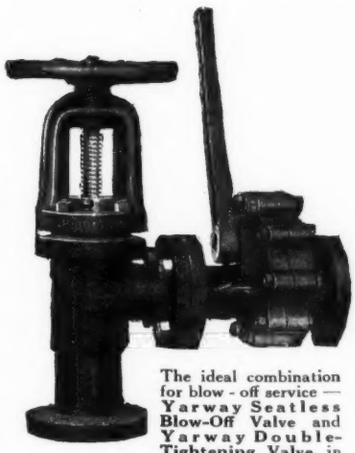
NELSON VALVE CO.

BALTIMORE—Key Highway and Boyle St.
BOSTON—131 State Street.
BUFFALO—15 West Swan Street.
CHICAGO—650 West Lake Street.
CLEVELAND—Leader-News Bldg.
CHARLOTTE—816 Realty Bldg.
DETROIT—242 Larned St., West.

CHESTNUT HILL
PHILADELPHIA

LOS ANGELES—228 Central Ave.
MINNEAPOLIS—632 Builders Ex.
NEW YORK—90 West Street.
PITTSBURGH—517 Liberty Ave.
SAN FRANCISCO—50 Fremont St.
SYRACUSE—504 City Bank Bldg.
SCRANTON—Wyoming Ave.

These
YARWAY SEATLESS BLOW-OFF VALVES
have been in continuous service since 1910



The ideal combination for blow-off service — **Yarway Seatless Blow-Off Valve** and **Yarway Double-Tightening Valve** in tandem.

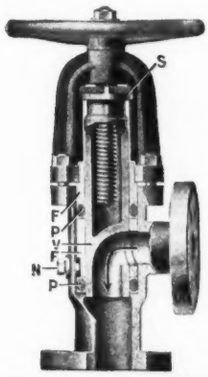
In June 1910, The Stanley Works installed three **YARWAY SEATLESS BLOW-OFF VALVES** in their New Britain, Conn., plant. Today, after more than twelve years of continuous service, these valves are still in good condition.

In March 1911, the same company installed three additional **YARWAY SEATLESS BLOW-OFF VALVES**; in May 1912, three more; in September 1912, three more; in December 1920, two more—a total of four repeat orders.

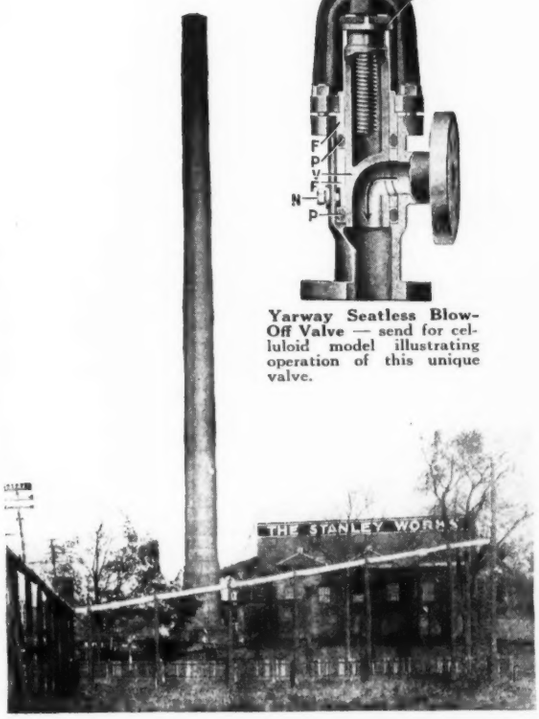
All of these valves are giving excellent service.

The Stanley Works is one of several hundred concerns that have made a *permanent* investment in **YARWAY SEATLESS BLOW-OFF VALVES.** Names and records of other users are given in Booklet B-410. There's a free copy here for you—write for it today.

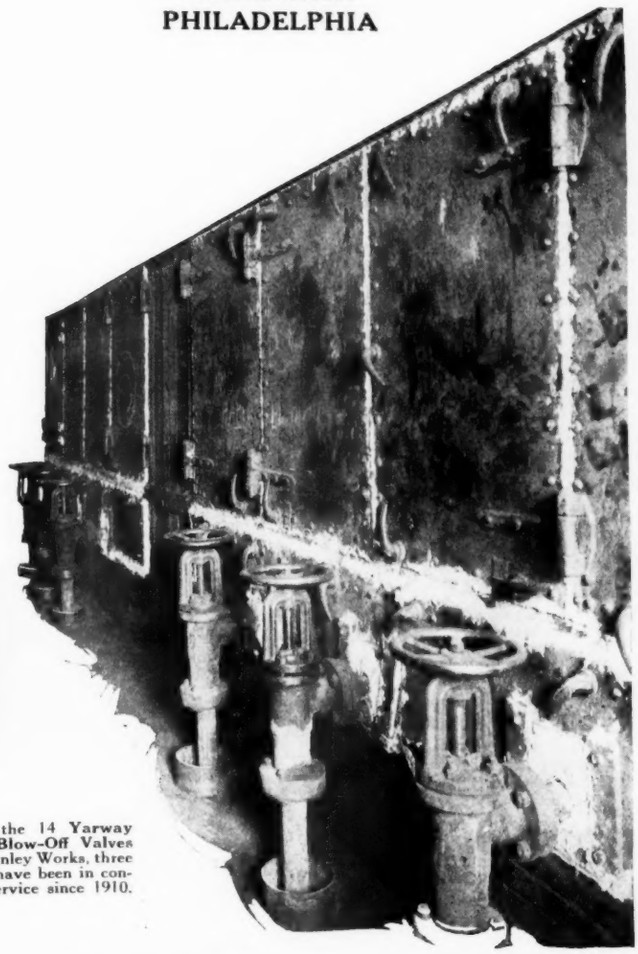
YARNALL-WARING CO.
Mermaid Avenue
PHILADELPHIA



Yarway Seatless Blow-Off Valve — send for celluloid model illustrating operation of this unique valve.



Plant of The Stanley Works at New Britain, Conn.



Some of the 14 **Yarway Seatless Blow-Off Valves** at The Stanley Works, three of which have been in continuous service since 1910.

YARWAY

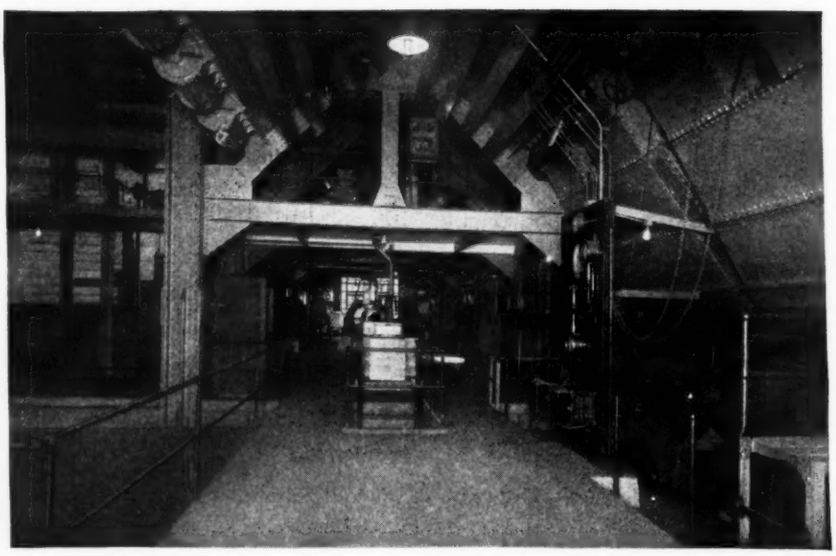
POWER PLANT DEVICES *to save fuel*

Design + Construction + Service =

THE TAYLOR STOKER

Now watch for our next story

This is Congress Street heating plant of Detroit Edison Co. On the right is the largest boiler in service in the world—2982 hp. (rated). It is fired by two 14-retort Taylor Stokers. Most of the boilers in Detroit Edison's immense plants are Taylor Stokered.



Just to give you a better idea of the capacity of this boiler—it will heat one thousand homes to a comfortable temperature in the coldest weather. And when you say coldest weather in Detroit, you mean real cold.

The experience of users of

The Taylor Stoker

is summed up in a letter from one of our customers to another concern.

"Lining up the whole proposition after a thorough investigation of all the stokers made, we decided that the Taylor Stoker was the best proposition on the market at the present time, and was best suited for our conditions. Personally, I do not think you will make a mistake in buying Taylors."

Money can't buy a better Stoker

American Engineering Company

Philadelphia

Manufactured in Canada by

TAYLOR STOKER COMPANY, LTD., TORONTO, ONT.

Principal Sales Office: 416 Phillips Place, Montreal, Que.

R
Model T. Lubricator
P
SCIENTIFIC LUBRICATION

Guaranteed Satisfaction!!

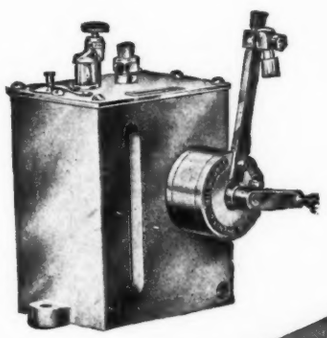
When an R-P Model T Lubricator is installed in your plant for the efficient lubrication of Steam Engines, Compressors, Pumps, Machine Tools, Steam Hammers — all kinds of industrial machinery—absolute satisfaction is guaranteed.

The Model T Lubricator is the highest grade, moderate priced Force Feed Lubricator on the market—A point by point comparison will bear out the truth of this statement.

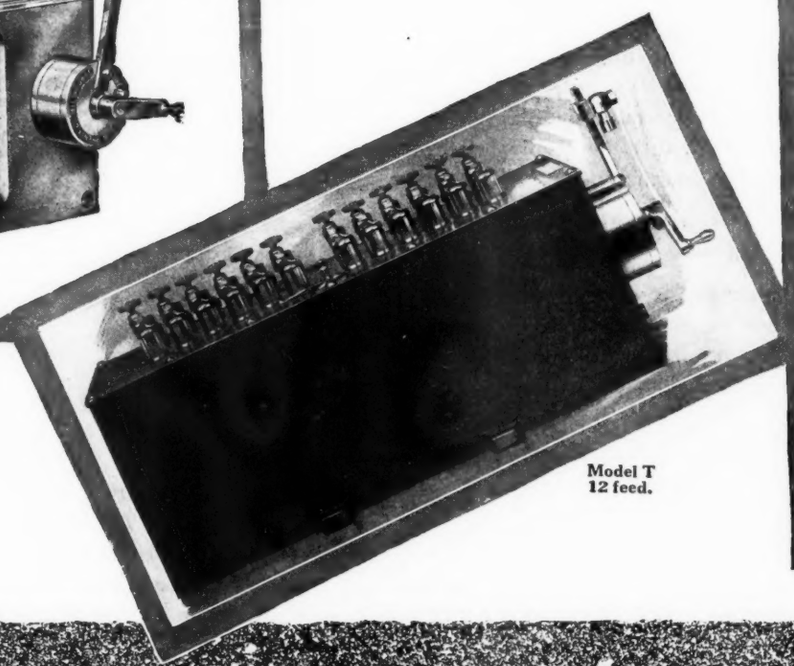
Remember—IT'S GUARANTEED!

Let our Engineers explain its adaptation to YOUR Power Plant equipment. No obligation on your part.

THE RICHARDSON-PHENIX DIVISION
S. F. BOWSER & CO., INC.
LUBRICATION ENGINEERS AND MANUFACTURERS
FORT WAYNE INDIANA
125 BOWSER AVE.
Sales Offices in all centers
Representatives everywhere



Model T
1 feed.



Model T
12 feed.

R P
OILING SYSTEMS

Central Oiling and Filtering Systems
Power Plant Oil Filters
Force Feed Lubricators
Sight Feed Oilers
Oil Pumps
Continuous Oiling Systems
NoKut Brass Valves
NoKut Pump Valves
NoKut Steel Valves

BOWSER

Self-Measuring Curb Pumps for Gasoline and Oil
Dry-Cleaners' Systems
Filling Station Equipment
Underground Tanks
Kerosene Pumps and Tanks
Paint Oil Storage and Handling Systems
Portable Gasoline and Oil Outfits

Can Any Flexible Coupling Cure Misalignment Troubles?

Accurate alignment between the shaft of any turbine and that of its driven machine is absolutely essential to smooth and efficient operation.

Some engineers do not believe that it is absolutely necessary to exercise unusual care in aligning the shafts of high-speed drives if a well-designed flexible coupling is used. Others place too much confidence in the ability of the cast iron bed plate to hold the two machines in line, assuming that any slight distortion is fully compensated for by the coupling. In either case, experience has shown that it is difficult to keep the glands tight and that excessive bearing wear occurs.

No flexible coupling can prevent vibration. Trouble and undue deterioration of the unit will occur, unless the shafts run true with every bearing in line.

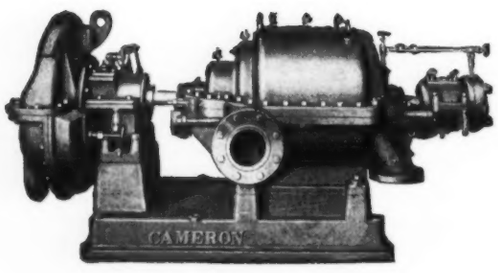
THE LONDON STEAM TURBINE Is Rigidly Coupled

It is radically different from all other turbine designs in that it actually becomes an integral part of the complete unit. The pedestal of the turbine takes the place of the inboard bearing of the driven member, so that the rigidly bolted shafts run in true alignment in only two bearings.

The total length of the shaft is less than in the case of three or four bearing units, resulting in less deflection and higher critical speed.

London Steam Turbine driven units remain in accurate alignment under the hardest service. Operating and repair costs are low. Their installation is a permanent economy in any plant that requires steam turbine drives from 5 to 500 horsepower.

Write for latest Turbine Catalog



This is the second of a series of advertisements in the London Steam Turbine, which began in the December 12th issue. To be continued next week.

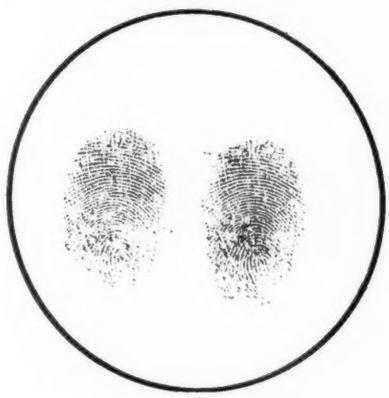
London Steam Turbine Co.
Troy, N. Y.

MAKE THIS TEST FOR CLEAN STEAM

DIRTY

Spots of Abrasive Dirt

CLEAN



Spots of Clean Oil

Dirty Steam Is Worse Than Dirty Oil

Take a filter paper or a piece of tissue paper and rub it over the inside surface of your engine cylinder, immediately after it has been opened up for inspection.

If the steam and oil have been clean and the cylinder properly lubricated the finger prints on the filter paper will show spots of clean oil. If the lubrication is faulty, or the steam dirty, the spots on the filter paper will be black. This will indicate the presence of dirt which in the majority of cases will be found to have come from impurities in the steam supplying the engine.

TRACY STEAM PURIFIERS
Insure your boilers delivering steam that is CLEAN and DRY.
NO DIRT - NO MOISTURE
NO IMPURITIES

Install TRACY STEAM PURIFIERS

in your boilers and let your oil really lubricate your cylinders and piston rods. See them take on that hard, mirror-like glaze that eliminates friction and wear. Simple to install.

MAIL US THIS COUPON ⟶

ANDREWS-BRADSHAW CO.
B.F.Jones Bldg. Pittsburgh, Pa.

CREASE, TEAR OFF AND SEND

Andrews-Bradshaw Co., B. F. Jones Bldg., Pittsburgh, Pa.

Dear Sirs:—Without obligation on my part you may send me your literature on the Tracy Steam Purifier and the proof of your claim for 100 per cent dry steam—100 per cent clean steam.

Name .....

Address .....

12-26-22

ASSUR

When you discuss Multiple Retort Stokers you can depend upon it that the recommendations of our engineers are free and unbiased by any controlling influence except your best interests.

INTERNATIONAL COMBUSTION

Combustion Engi

Combustion Engineering Bldg

Offices in Principal Cities

Frederick Multiple Retort Stokers
Type E Stokers
Type D Stokers
Type K Stokers
Type H Stokers
Self Contained Stokers

COMBUSTION ENGINEERING NEW YORK CORPORATION

RANCE

THE NEW FREDERICK STOKER

is the stoker that forecasted months ago the redesigning of Multiple Retort Stokers in an effort to keep up with the pace of ***service to your*** interests, set by this stoker.

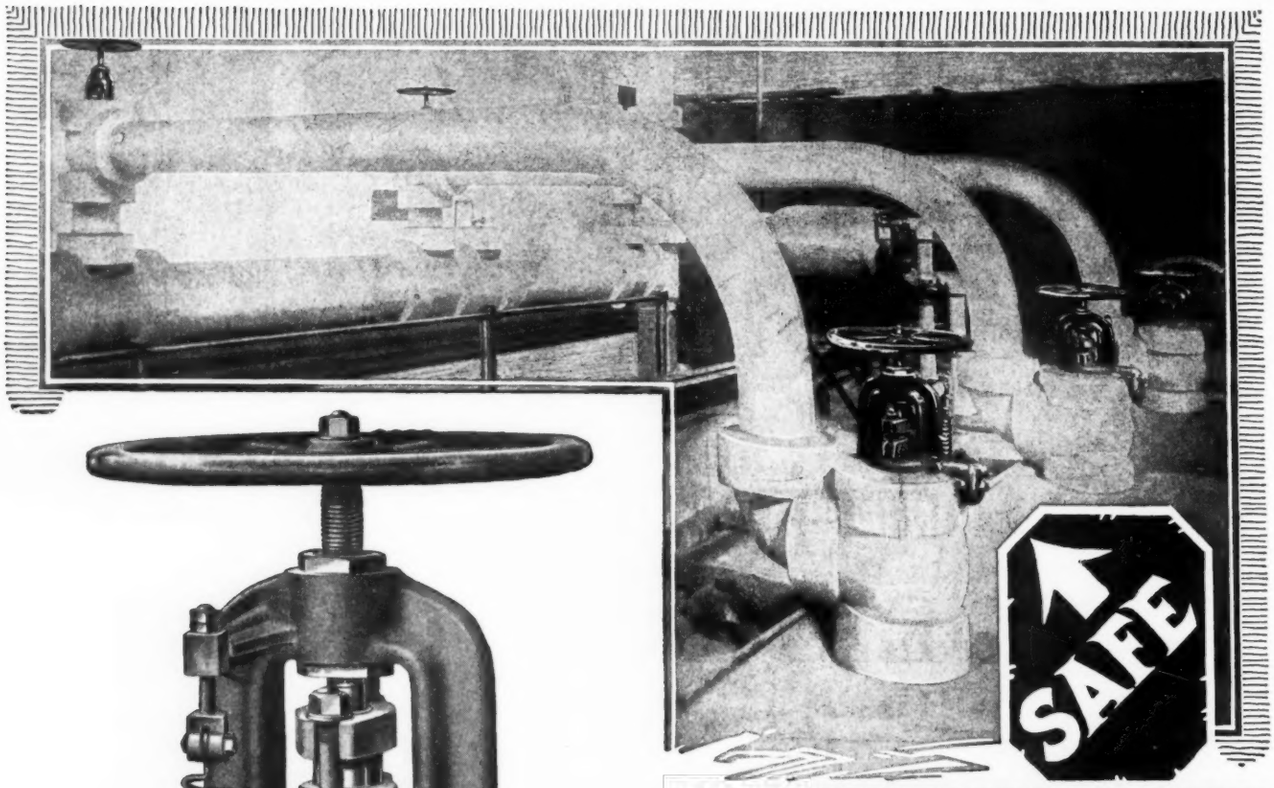
ENGINEERING CORPORATION

ngineering Corporation

Bldg 43 Broad Street New York City

Throughout the World

Lopulco Pulverized Fuel Systems
Coxe Stokers
Grieve Grates
Air Heaters
CEC Tube Scraping Device
Combusco Water Seal Conveyors



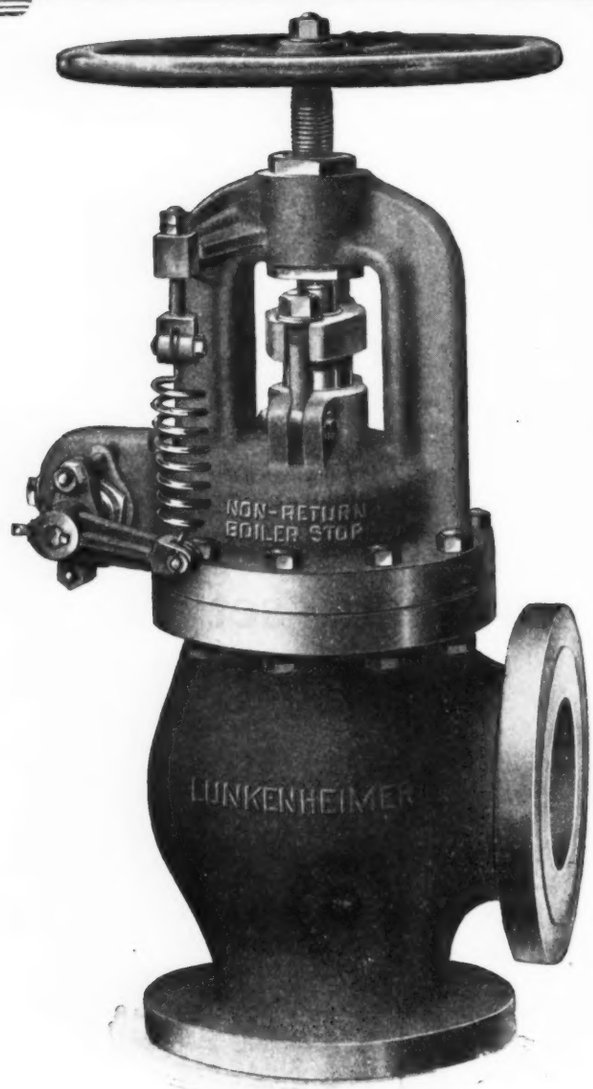


Fig. 700

LUNKENHEIMER

Safety Non-Return Valves

are safety devices of established merit, providing positive protection to the operatives as well as the plant itself, against the dangers incident to an internal accident to one of the boilers of a battery.

A sudden drop in pressure within the boiler will cause the Lunkenheimer Non-Return Safety Boiler Stop Valve to close instantly and it will not reopen until the pressure within the boiler is raised to that in the header as these valves cannot be opened by hand. They likewise safeguard the lives of workmen who enter a dead boiler, should the regular stop valve fail or be opened through carelessness.

Lunkenheimer construction provides extreme factors of safety,—vital to the severe service these valves perform; minute adjustment to meet individual operating condition and durability far beyond the average.

Iron Body Bronze Mounted and Cast Steel Monel Mounted for all pressure and temperature conditions.

"America's Best since 1862"

"Essential for the safe operation of boilers connected in battery"

THE LUNKENHEIMER CO.
—"QUALITY"—
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD
NEW YORK CHICAGO **CINCINNATI, U. S. A.** BOSTON LONDON
EXPORT DEPT. 129-135 LAFAYETTE ST., NEW YORK

10-19-13

No. 4

OF A SERIES OF ARTICLES PICTURING THE INFLUENCE OF THE ENGINEER IN THE AFFAIRS OF THE WORLD. PRESENTED BY THE McGRAW-HILL COMPANY, INC., WHOSE PUBLICATIONS HAVE SERVED THE ENGINEER THROUGH HALF A CENTURY OF INDUSTRIAL PROGRESS

Coal Age

Electrical World

Electrical Merchandising

American Machinist

Industrial Engineer (Published in Chicago)

Engineering and Mining Journal-Press

American Machinist European Edition (London)

THE BREADTH OF ECONOMICS

AN old word with a new meaning has been introduced into the affairs of men. The power of words is very great and an understanding of them is one of the essentials to progress.

¶ The advancement of humanity hinges, to an almost menacing extent, upon a complete conception of the word *economics*. Once popularly confined to finance, it has grown to involve the whole realm of human activity.

¶ Now man is the economic factor in the work of the world. Whatever he does, the result—time, effort, ability and resources engaged—must prove up under the standards of economics, or be judged unworthy.

¶ But who has brought about this change, this revision in the conception of man's advancement, of man's inevitable responsibility? And who has given this word so vast a power over human destinies and has caused so gigantic a revolution for the benefit of all humanity?

¶ The engineer. His is the responsibility. He it is who has introduced economics into all the affairs of men. He it is who has provided the world with a new basis for judgment and appreciation.

¶ The engineer, who has made life assume a scientific instead of a chaotic aspect; who has developed an exactness of procedure; who has worked out cause and effect on a calculable basis; who is even now reducing the fever of misapplication of life's priceless energies and putting them to the service of constructive happiness.

¶ It will be many generations before the mass of humanity knows and acknowledges its debt to the engineer, who so quietly brings about such stupendous revolutions and revelations, and who takes the past and links it to the present for the benefit of the future.

¶ Yet while the acknowledgment may be long in coming, the engineer has his reward in the knowledge of work well done, in the joy of accomplishment, in the feeling of power which gives him the opportunity to direct the courses of men even before they are aware of the source of authority.

Power

Engineering News-Record

Bus Transportation

Electric Railway Journal

Ingenieria Internacional (Printed in Spanish)

Chemical and Metallurgical Engineering

Journal of Electricity and Western Industry (San Francisco)

McGRAW-HILL COMPANY · INC ·

NEW YORK

FROM GILBERT'S

DE MAGNETE —

"WORD MONGERS" *and* "CHATTERING BARBERS"

"Word mongers" and "chattering barbers," Gilbert called those of his predecessors who asserted that a wound made by a magnetized needle was painless, that a magnet will attract silver, that the diamond will draw iron, that the magnet thirsts and dies in the absence of iron, that a magnet, pulverized and taken with sweetened water, will cure headaches and prevent fat.

Before Gilbert died in 1603, he had done much to explain magnetism and electricity through experiment. He found that by hammering iron held in a magnetic meridian it can be magnetized. He discovered that the compass needle is controlled by the earth's magnetism and that one magnet can remagnetize another that has lost its power. He noted the common electrical attraction of rubbed bodies, among them diamonds, as well as glass, crystals, and stones, and was the first to study electricity as a distinct force.

"Not in books, but in things themselves, look for knowledge," he shouted. This man helped to revolutionize methods of thinking—helped to make electricity what it has become. His fellow men were little concerned with him and his experiments. "Will Queen Elizabeth marry—and whom?" they were asking.

Elizabeth's flirtations mean little to us. Gilbert's method means much. It is the method that has made modern electricity what it has become, the method which enabled the Research Laboratories of the General Electric Company to discover new electrical principles now applied in transmitting power for hundreds of miles, in lighting homes electrically, in aiding physicians with the X-rays, in freeing civilization from drudgery.

General Electric

General Office Company *Schenectady, N.Y.*

95624 H. D.

Harrington Stokers burn every kind of coal—insure high efficiencies over a wide range of capacities—and operate with minimum maintenance costs.

Where Power is the Product

CENTRAL stations have one object—to deliver power at the greatest profit. Greater power at lower cost is their whole goal.

Whatever central stations practice is worth heeding by other concerns with a power plant—whether they make shoes, soap or soup.

Central stations are turning more and more to the Harrington Stoker and this fact holds a lesson of prime importance to industrial executives.

One of the largest central stations, The Cleveland Electric Illuminating Co. placed an order for 9 Harrington Stokers in May 1920. After thoroughly testing and comparing the Harrington Stokers with other stokers in the same plant, they ordered 18 additional Harringtons.

Central stations and manufacturers alike are lowering fuel costs and are improving plant efficiency with Harrington Stokers.

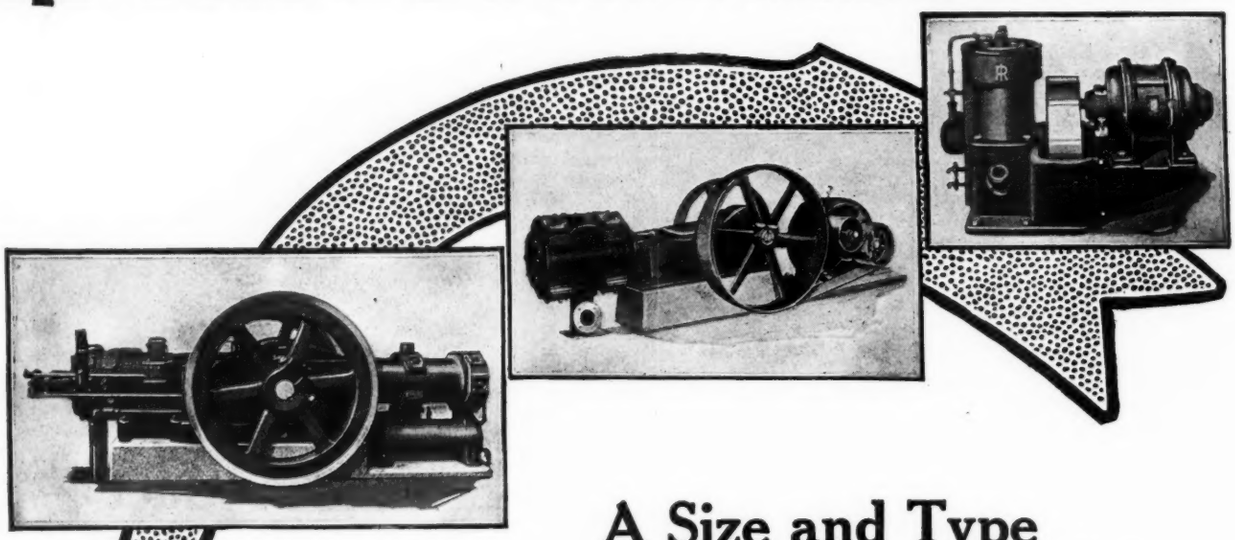
The Harrington is the only stoker that will burn every kind of coal under any plant condition. The unique grate construction of the Harrington makes it non-sifting and automatically self-cleaning. The Harrington has many other features that will interest you.

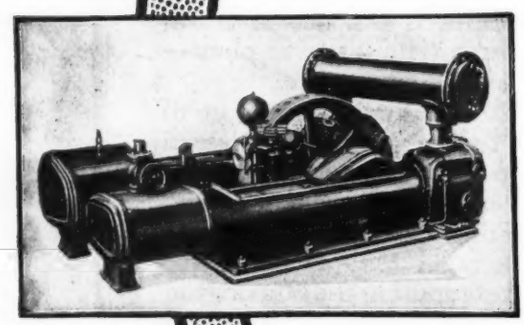
Write for ***"Twelve Fuel Facts"***.

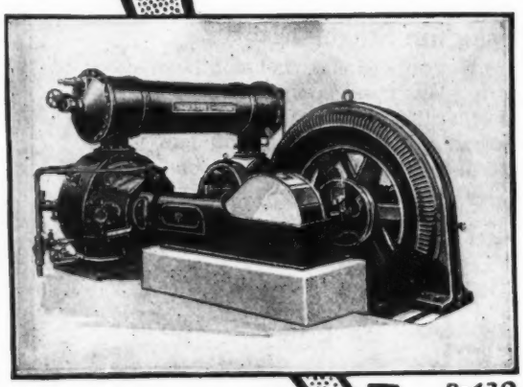
THE UNITED MACHINE & MFG. CO.
CANTON OHIO
DEPT. M
Branches
New York, Philadelphia, Pittsburgh, Atlanta, Cleveland, Chicago, Detroit, Seattle, Saint Paul, Columbus, Kansas City

THE HARRINGTON STOKER

IR AIR COMPRESSORS







R-430

A Size and Type For Every Condition

NO matter what capacity, pressure or type of drive, one of the thousand and more types and sizes of Ingersoll-Rand Air Compressors will just fit your requirements.

There are standard compressors for pressures up to 3,500 pounds per square inch, and for capacities ranging from 3 to 50,000 cubic feet of free air per minute.

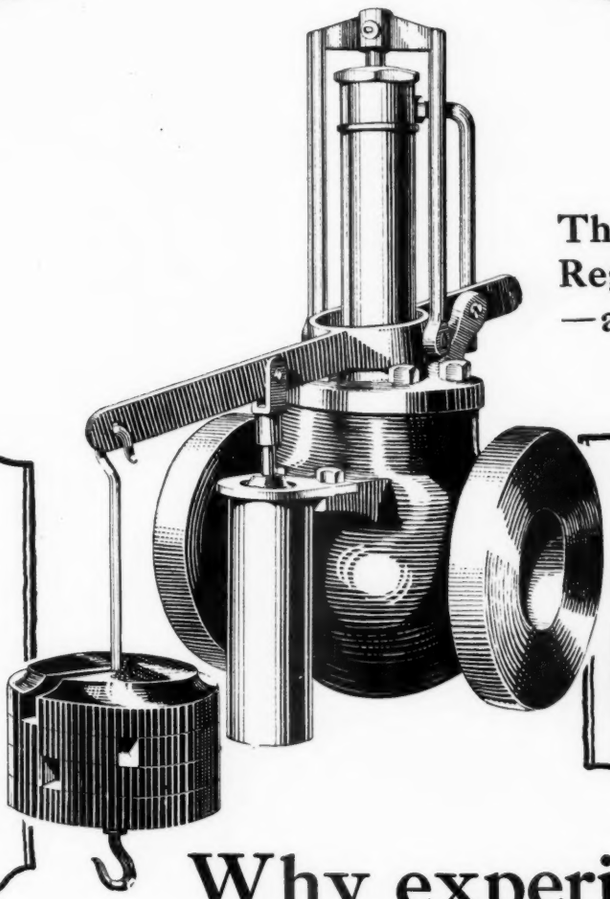
The question of drive has been given the most careful consideration. Whether direct-connected electric motor drive, oil or gas engine, belt or steam drive is preferred you can purchase the *complete* compressor unit from the Ingersoll-Rand Company, with the assurance that every detail of compressor and prime-mover has been given correct attention.

In addition to air compressors the Ingersoll-Rand Company manufacture a complete line of gas and ammonia compressors. Our engineers are located in all parts of the world. These men are experts on the subject of air and gas compression and will be glad to discuss your problem with you. Also, these compressors are described in illustrated booklets, copies of which will be sent you on request.

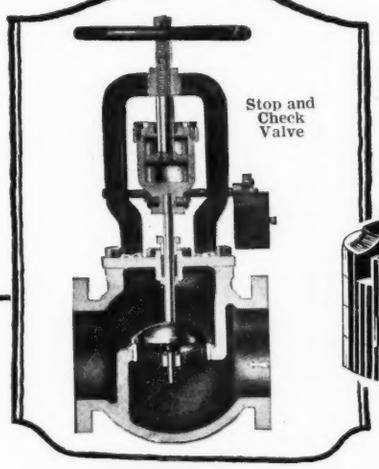
INGERSOLL-RAND COMPANY
11 Broadway, New York
Offices in all principal domestic and foreign cities.

671-C

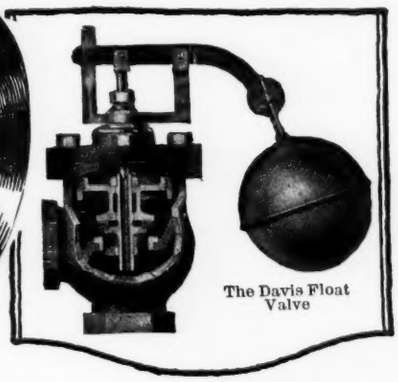
Ingersoll-Rand



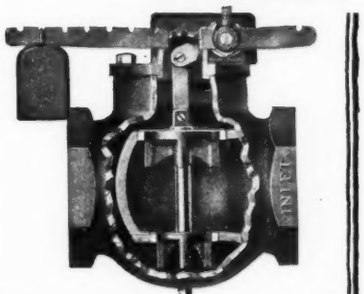
The Davis Regulator —a safe investment



Stop and Check Valve



The Davis Float Valve



Back Pressure Valve

Why experiment

—when others have done the experimenting for you?

WHY gamble? Why accept a substitute—an untried valve specialty—when you can get a device backed by almost a half century of dependable service.

For forty years engineers have been testing the Davis Pressure Regulator for you. In service, it has shown that it will unfailingly reduce a high steam pressure to any required lower pressure and maintain the reduced pressure constant.

The Davis Back Pressure Valve is equally tried. It is known to be positive. It never sticks or binds. It is noiseless. It will maintain a constant back pressure for heating, drying, cooking and other processes using steam.

Neither do you experiment when you try Davis Float Valves. They have single seats with renewable composition discs which make them close tight and prevent leakage.

Davis Stop and Check Valves have their dash pot outside of the valve body away from the action of the steam where it cannot cause trouble. Ask the G. M. Davis Regulator Co., 420 Milwaukee Ave., Chicago, for details of these and the other valve specialties listed opposite.

Water Control Valve
Non-Return Valve
Exhaust Relief Valve
Balanced Valve
Pump Governor
Emergency Stop Valve
Flow Regulator
Fluid Level Controller
Water Relief Valve
Steam Trap

DAVIS VALVE SPECIALTIES

STEAM SAVERS SINCE 1875

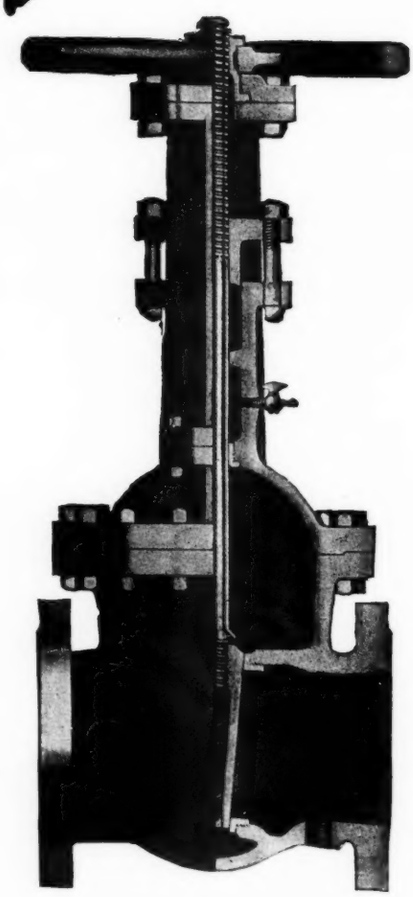
—where others have failed!

CHAPMAN

Guaranteed to 1927!

—to CONTROL Superheated Steam

Here is a Cast Steel Gate Valve backed by a definite 5-year GUARANTEE. We can make this guarantee because WE KNOW this Valve. It is built especially for high pressure. Body and cap of cast steel. Spindle of rolled monel. Spindle seats and seat rings of cast monel. And observe the long neck, so designed that the intense heat cannot reach the packing. Ask any man who has installed "List 63½" and we will stand or fall by his say-so, not ours. Fully described in the Chapman Catalog. Send for your copy.



The Chapman Valve Mfg. Company
Indian Orchard, Mass.

BRANCHES:

New York	Pittsburgh	Detroit	Chicago
Boston	Philadelphia	Cleveland	Los Angeles
Tulsa	San Francisco	Houston	Syracuse

VALVES

STRONG

SAYS:

"A Separator Worth While Should Do MORE Than Just Protect Your Cylinder Heads"

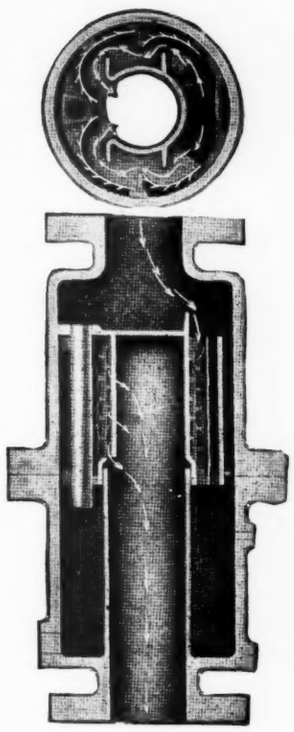
A very ordinary separator will do that much for you—save your cylinder heads. But if it fails to do more—fails to give you DRY steam—you will still be losing money.

It is stated on authority that for every one per cent of moisture in steam where it reaches the engine, there is another one per cent of loss in using it in that condition. If the engine is running below rating there is a possible loss of three times as much.

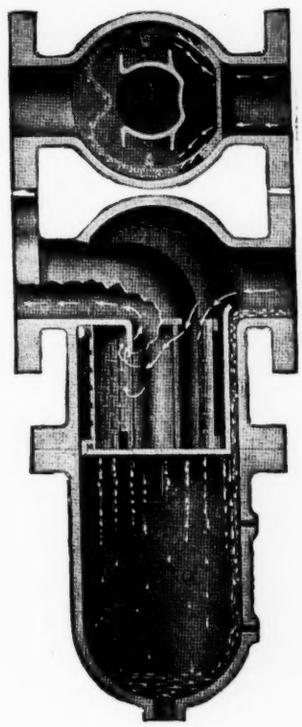
It is therefore evident that the ACTUAL WORTH of a separator is the RESULT IT WILL GIVE IN DRY STEAM.

We GUARANTEE better than 99% dry steam. STRONG Separators remove oil and condensation from the exhaust line from the engine with the same high degree of efficiency as entrained moisture and water from the steam line to the engine.

Our Catalog explains fully the theory, operation and construction of these separators. If you will refer to it you will be convinced of their superiority.



Vertical Type



Horizontal Type

Mail the Coupon!

The Strong, Carlisle & Hammond Co., Cleveland, Ohio
Gentlemen:—Please send me a copy of your latest Catalog, No. 18-P, at your earliest convenience.

Name.....

Address.....

.....1922

12-26-22

The Strong, Carlisle and Hammond Co.

Cleveland, Ohio

Tanktred Type Loader. The caterpillar traction insures safe travelling over soft or uneven ground.

Type "G" Radial Loader. The rugged construction of Jeffrey Portable Bucket Loaders especially adapts them to severe service.

Store or Reclaim Your Coal With

JEFFREY

PORTABLE LOADERS

Bucket Loaders—Radial and TANKTRED Type Capacity $1\frac{1}{2}$ to 2 cubic yards per minute. Will not only ***load*** loose materials, but will readily ***dig*** hard material without requiring hand shoveling or mechanical devices to bring material to the buckets.

Portable Belt Conveyers. Capacity 20 to 50 tons per hour. The foot end of conveyer may be easily rammed into the pile, allowing material to flow or be raked onto belt and thus save shoveling.

Write for Catalogs, and give us full particulars concerning your requirements.

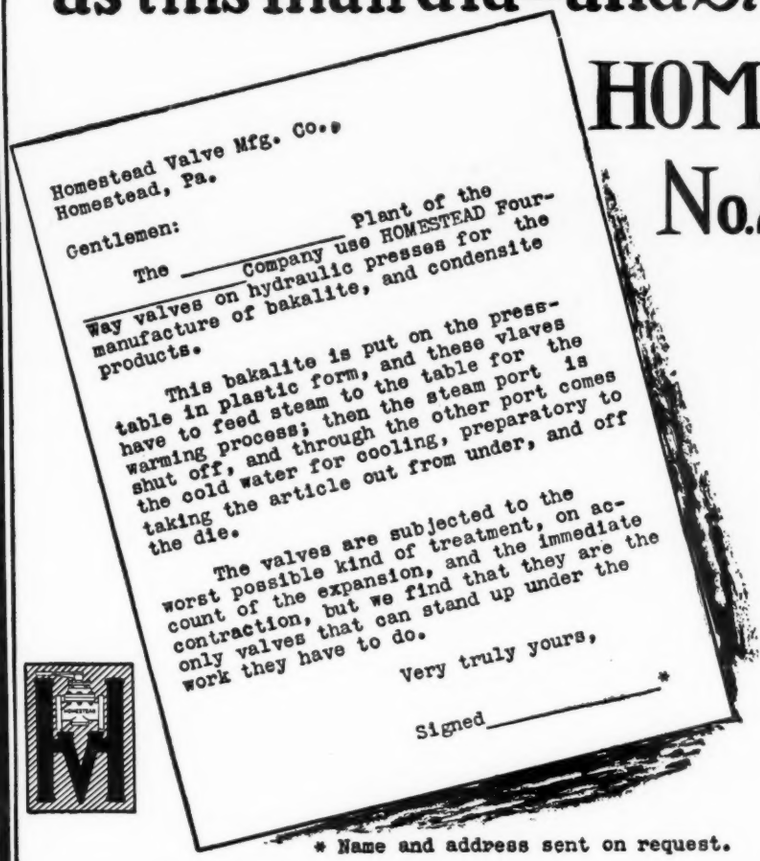
The Jeffrey Mfg. Co. 932-99 North Fourth Street Columbus, Ohio

Two or more Jeffrey Portable Belt Conveyers may be used to increase storage capacity.

The Jeffrey Portable Belt Conveyer meets the demand for a light, durable and inexpensive conveyer where the volume of coal handled is comparatively small.

Look Over Your Valves

as this man did—and *Standardize* on HOMESTEADS



Homestead Valve Mfg. Co.,
Homestead, Pa.

Gentlemen:

The _____ Plant of the _____ Company use HOMESTEAD Four-Way valves on hydraulic presses for the manufacture of bakalite, and condensite products.

This bakalite is put on the press-table in plastic form, and these vlaves have to feed steam to the table for the warming process; then the steam port is shut off, and through the other port comes the cold water for cooling, preparatory to taking the article out from under, and off the die.

The valves are subjected to the worst possible kind of treatment, on account of the expansion, and the immediate contraction, but we find that they are the only valves that can stand up under the work they have to do.

Very truly yours,

Signed _____ *

* Name and address sent on request.

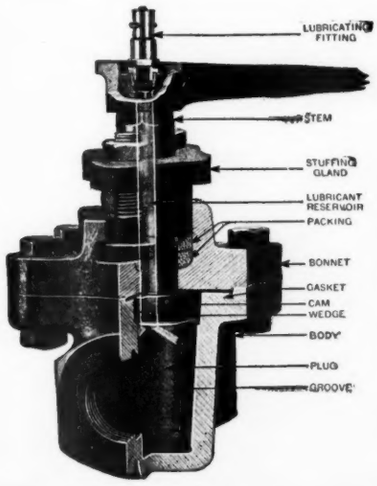
No. 2 Experiences With Homestead Valves

PERHAPS, like this man, you have had an interesting *experience* with Homestead Valves—if you will tell us about it, we will send you a pocket-size leather note book with renewable filler as a reward for your effort.

HOMESTEAD Quarter-Turn Valves are made in Straightway, Three-Way, Four-Way and Angle Patterns, both Lubricated and non-lubricated. All are of the plug cock type, opening and closing with a quarter-turn of the plug. A special cam, recently redesigned, holds the plug firmly in its seat at all times, and prevents by-passing or the deposit of sediment between the plug and the seat. Hovalco Blow-Off Valves are made with special discs and seats that are reversible, regrindable, renewable.

Our new catalog (just off press) will interest you—write today for your copy.

HOMESTEAD VALVE MFG. CO.
134 Sixth Avenue, Homestead, Pa.



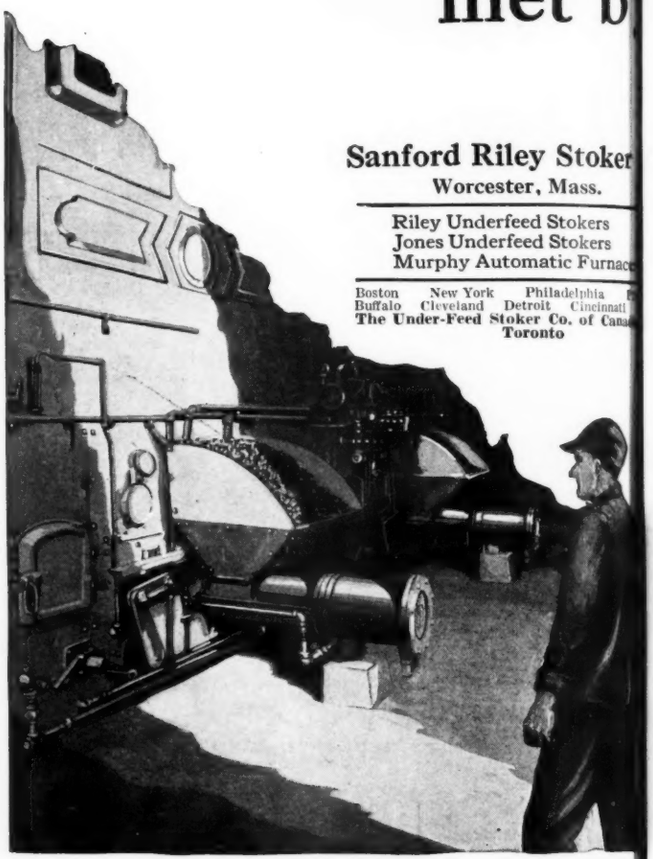
Here's Something New—The Homestead Lubricated Quarter-Turn Valve. Ask for descriptive literature.

HOMESTEAD

The story of a new development

THE basic advantages of the stoker itself, its application in prominent plants, and the field it serves, are all described and explained in this new booklet. Applications of the *"Lateral Retort"* Stoker to representative settings are also illustrated. Ask for this interesting story of a stoker that meets formerly unfulfilled conditions.

met b



Sanford Riley Stoker
Worcester, Mass.

Riley Underfeed Stokers
Jones Underfeed Stokers
Murphy Automatic Furnace

Boston New York Philadelphia
Buffalo Cleveland Detroit Cincinnati
The Under-Feed Stoker Co. of Canada
Toronto

RILEY JONES
SANFORD RILEY STOKER CO.
TRADE MARK Rx REGISTERED
MURPHY

The Under-Feed Stoker Company of America, originator of the *"Lateral Retort"* and the Jones Stokers, a division of the Sanford Riley Stoker Company of Worcester, Mass. Riley, Jones and Murphy Stokers are sold through the Sanford Riley Stoker Company and its branches.

The Under-Feed Stoker Company of Canada, Ltd., directs the sale of the three stokers in Canada.

fulfills conditions no other stoker!

THE *"Lateral Retort"* Stoker should *not* be considered either as a substitute for, or an improvement on, the multiple retort type of stoker. It is rather a new type of multiple retort stoker — a type that makes multiple retort stoking possible in many plants that otherwise would be compelled to install an inferior type of stoker.

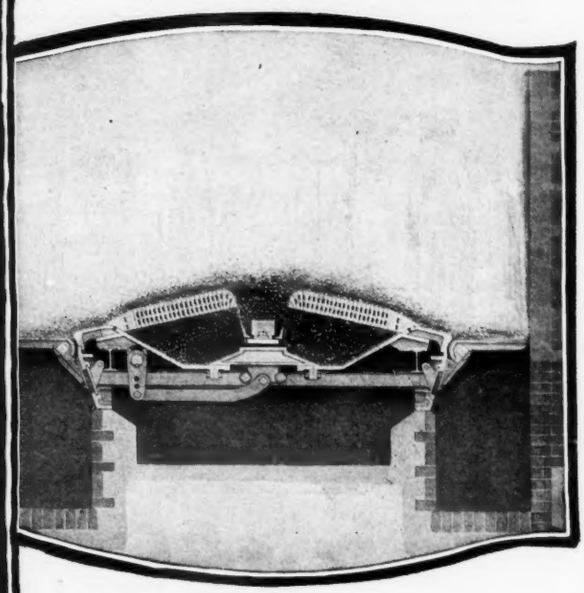
By embodying a multiple retort arrangement in a single stoker that follows the general design of simple side-cleaning stokers, a number of problems are solved in a remarkably simple way.

For instance, the necessity for basement ash pits is eliminated, since an excavation of 6 to 18 inches provides sufficient space for the two pits into which the ashes are discharged by the simple, side-dump plates. This greatly reduces installation cost and makes the *"Lateral Retort"* Stoker highly adaptable to old boilers in existing plants. Moreover, since the stoker is set very low, ample combustion space is insured when it is placed under low set boilers.

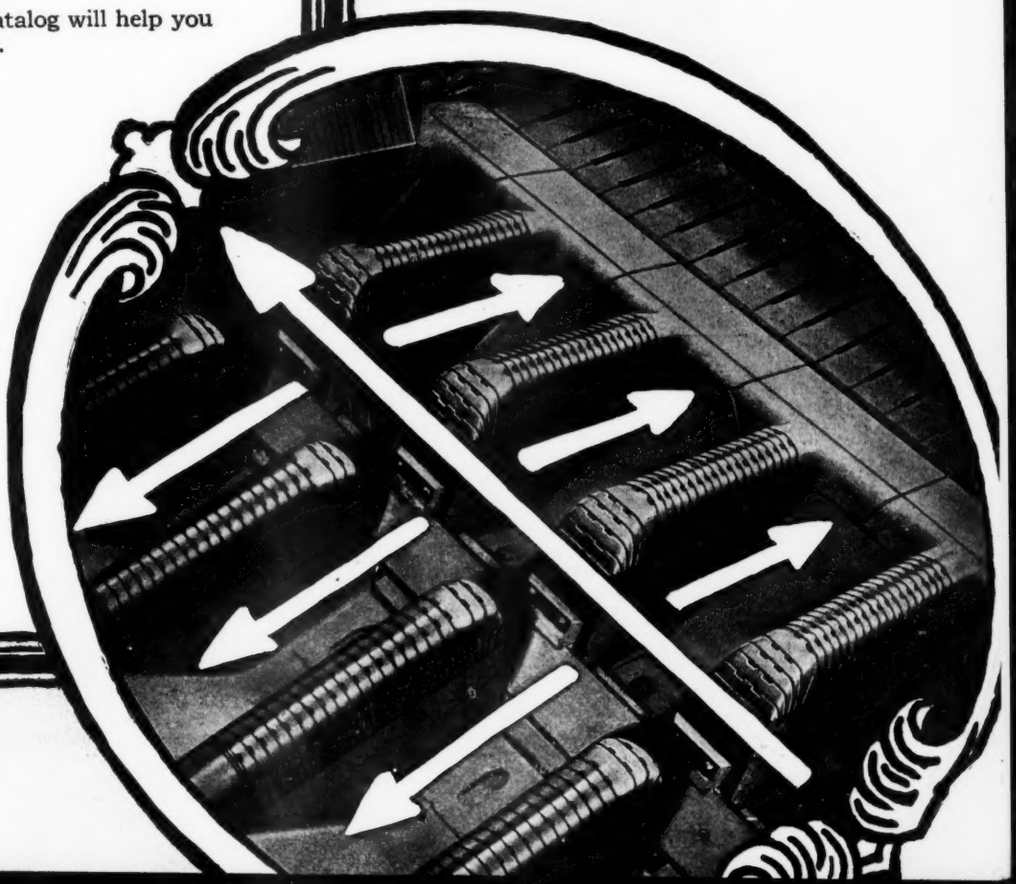
Thus in many ways the *"Lateral Retort"* Stoker stands alone. It is the only side-cleaning stoker in which the coal is underfed throughout, giving the greater fuel economy and overload capacity of multiple retort stoking; and therefore it is the one moderate priced, economically installed stoker that in any way rivals the multiple retort type.

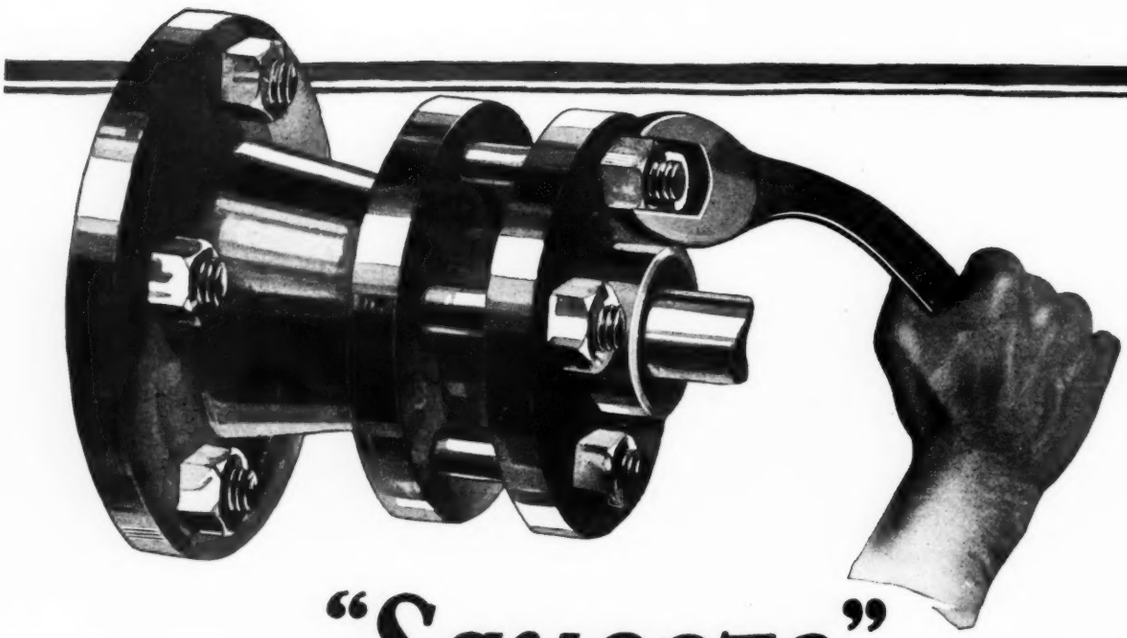
Conditions met by no other stoker; Are they your conditions?

The catalog will help you decide.



THE sectional elevation, above, illustrates the extreme simplicity of the *"Lateral Retort"* Stoker. Below is a top view showing the plate tuyeres which reduce siftings and lower replacement cost. Note, also, the high, air cooled front and rear tuyere blocks which keep fire and clinkers away from the front and bridge walls, greatly reducing furnace maintenance.





"Squeeze"

—ruins packing and wastes power

Squeezed up gland nuts destroy ordinary rod and plunger packing by friction, using up valuable power in the process.

Johns-Manville Sea Rings do away with squeeze—they are merely held in place by the gland.

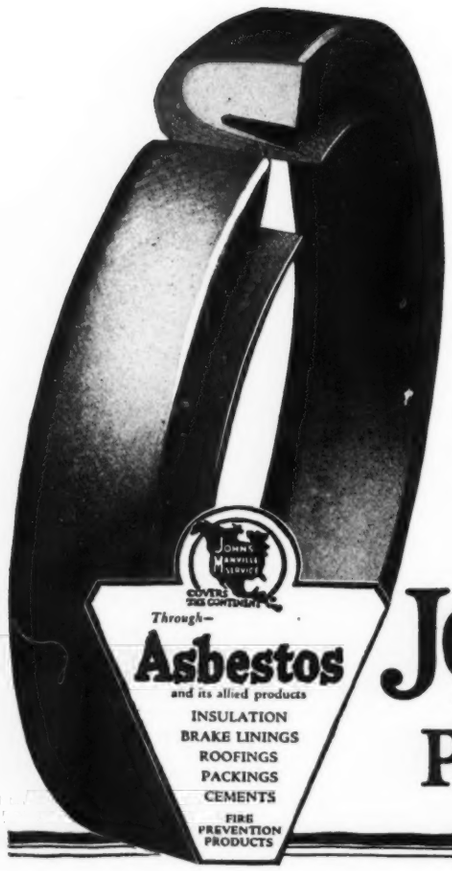
Packing action is automatic. The U-shaped Sea Ring section is expanded to prevent leakage by the pressure it packs against. The pressure against the rod is just proportionate to pressure in the cylinder and through the stuffing box. Friction is reduced to the minimum.

As a result, Sea Rings will greatly outlast ordinary packings. Records of five years or more on steam and air service are not uncommon, although much depends on the service.

Few engineers realize the power wasted by stuffing box friction. A test by the Tidewater Paper Company on an electrically driven triplex pump showed a Sea Ring power saving of $167.73 per year over ordinary flax packing.

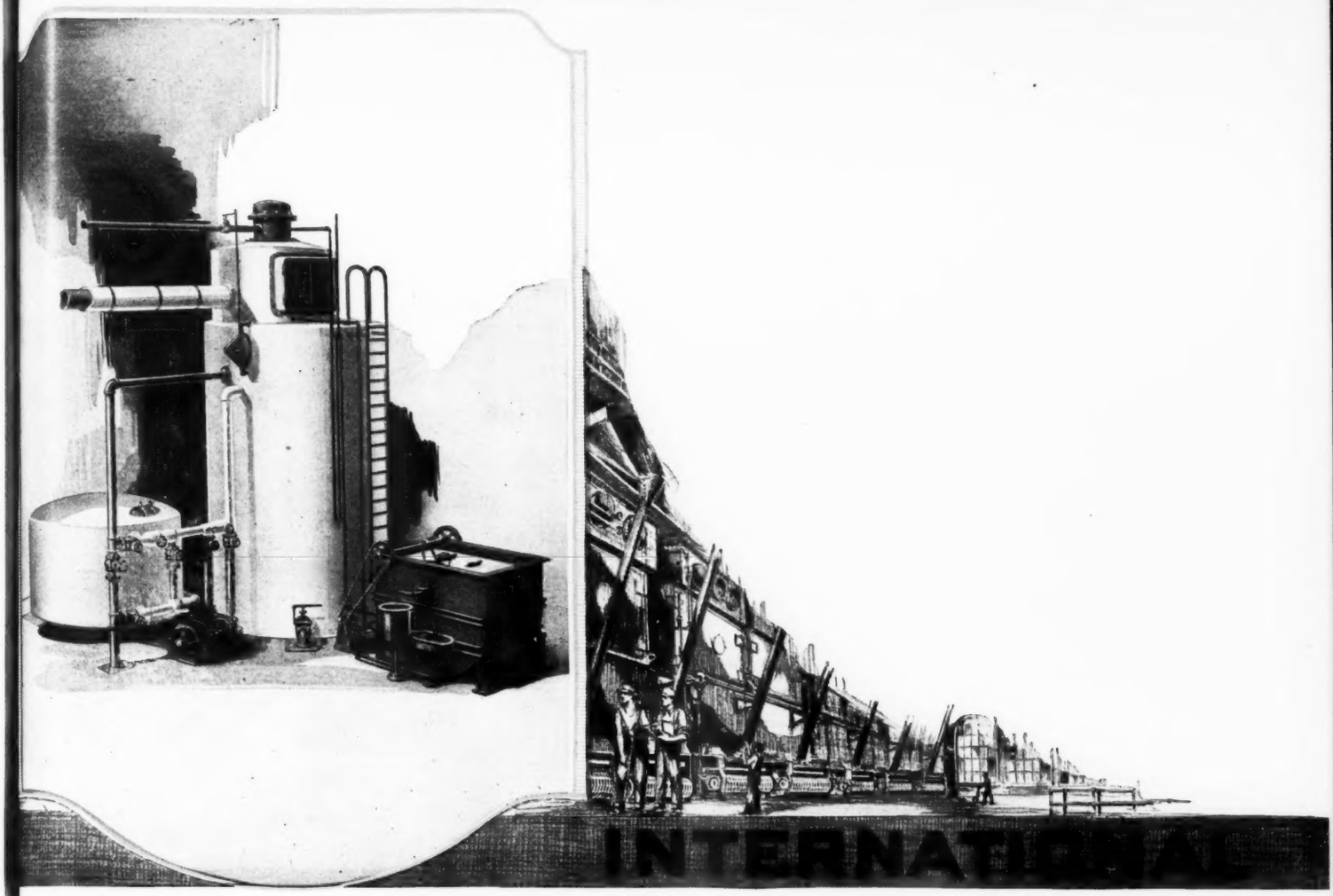
Surely Sea Rings are worth investigating.

JOHNS-MANVILLE, Inc., Madison Ave. at 41st St., N. Y. C.
Branches in 56 Large Cities
For Canada: CANADIAN JOHNS-MANVILLE, CO., Ltd., Toronto



JOHNS-MANVILLE

Power Plant Materials



Any Scale is Too Much—

—even the thinnest eggshell scale lowers the operating efficiency of the modern boiler plant

Turbining and other mechanical means of removing scale are admissions that you are fighting a losing battle with scale.

The only time your boilers are entirely free from scale is immediately after the cleaning periods. No matter how frequent the cleanings, the average scale condition must equal, at least, one-half the scale thickness at the time of the cleaning. Boiler compounds are only partially effective, and the steam boiler is no place for chemical reactions.

The very least you can expect of a water softener is the prevention of scale. Adding proper amounts of lime and soda-ash to any water removes the scale-forming matter, and it is impossible for a water softened in this way to form scale. The water softener merely controls the process of water softening and success or failure depends on the ability of the water softener to unfailingly and automatically control the various steps of the process before the water reaches the boiler.

The International Hot-Flow Softener not only controls the various steps of the water softening process unfailingly and automatically, but utilizes the advantages of treating the water hot, and delivers a clean, clear, *uniformly* softened water that is guaranteed not to form scale.

INTERNATIONAL FILTER CO.
Works and General Office
333 West 25th Place, Chicago
Canadian International Filter Co., Ltd., Toronto

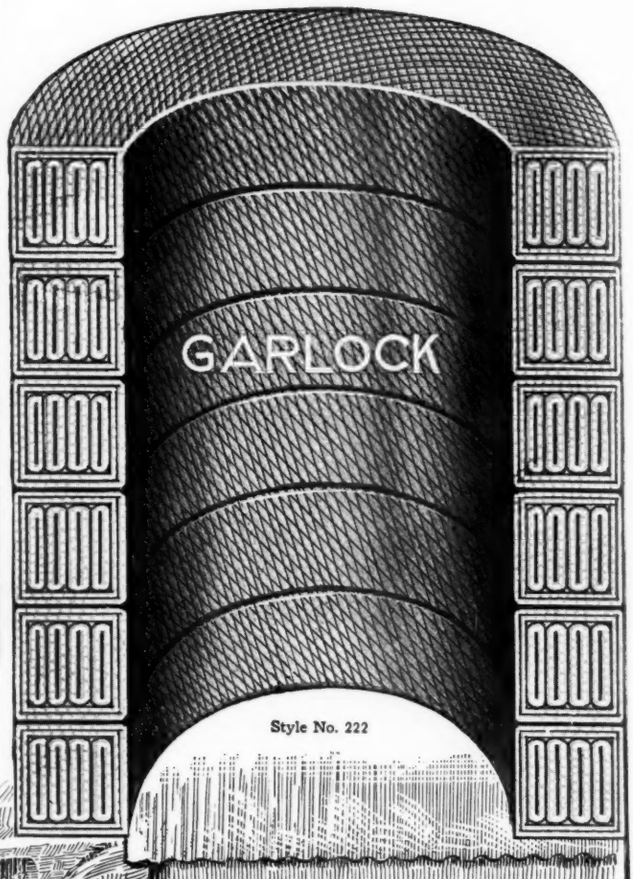
INTERNATIONAL WATER SOFTENERS

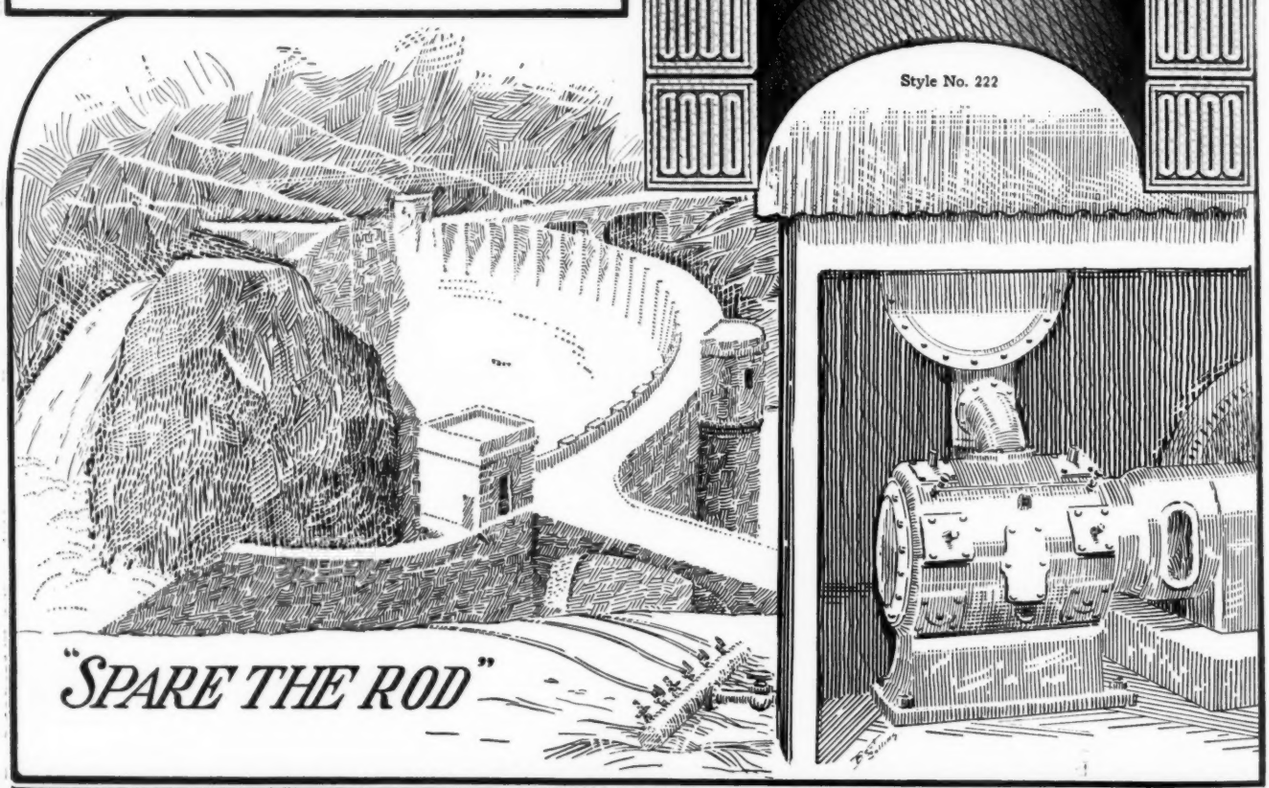
On Great Engineering Projects

Following the hose and pipe lines from clanking rock drills, back perhaps to a shanty open to dust and dirt, we come to the throbbing air compressor.

The compressor rod packing forms an important item contributing toward successful and continuous operation. The intense dry heat of compression, together with the abrasive action of grit and dust, soon destroy a packing not designed for this trying service.

Garlock Style No. 222 combination packing, designed with a thorough understanding of compressor requirements, has given efficient and continuous service on compressor rods under all conditions.





GARLOCK PACKINGS

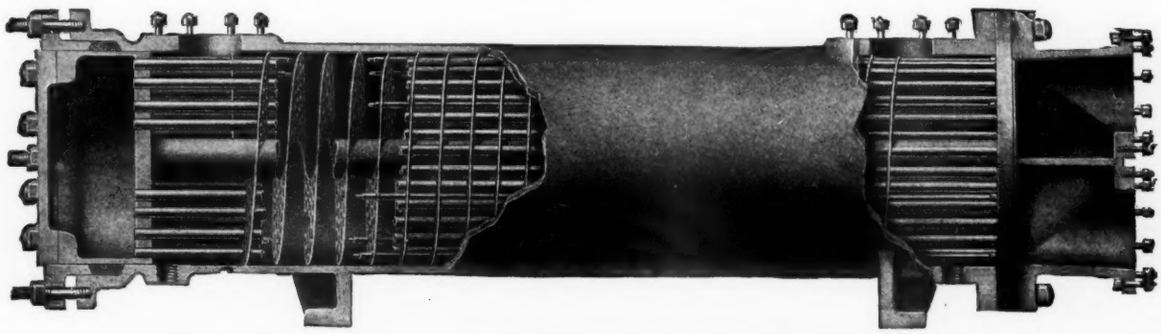
THE GARLOCK PACKING COMPANY

Branches:

New York, Chicago, Philadelphia, St. Louis, Boston, Cleveland, Pittsburgh, San Francisco, Denver, Birmingham, Hamilton, Ont.

How to Extend the Life of Your Turbine Bearings

Clean COOL Lubricating Oil will do it. But the oil must be cooled to the right temperature in order to maintain a film of the proper viscosity between the bearing surfaces to efficiently absorb and carry off the heat.



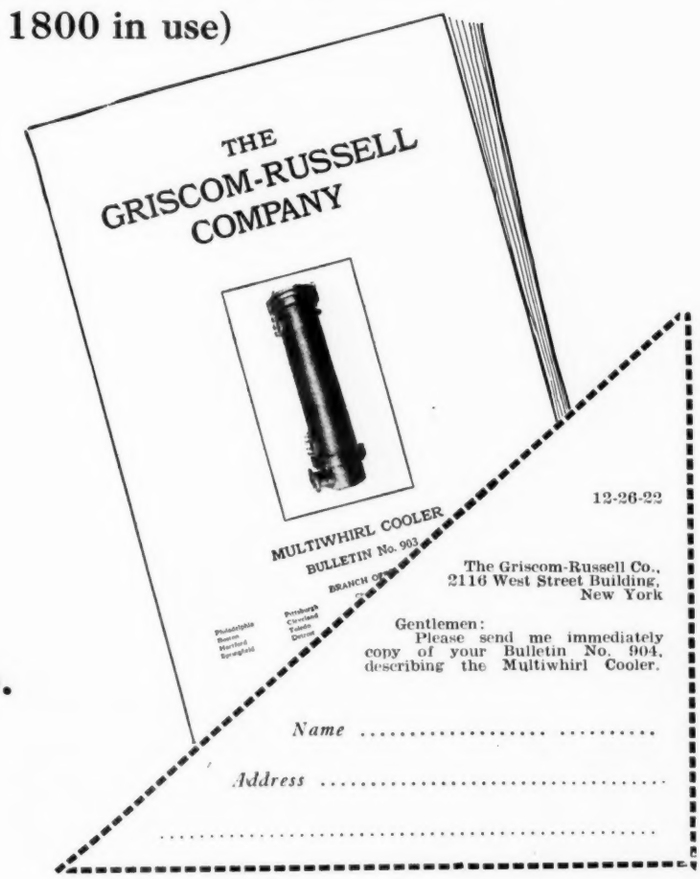
MULTIWHIRL COOLERS

(Over 1800 in use)

will continuously re-cool the oil circulated through turbine lubricating systems.

The many advantages, incorporated in their design such as: the helical baffle which causes the oil to swirl many times across the nest of water cooled tubes; the floating tube head to take care of expansion; the absence of sweated tube joints; the outside packed head that prevents seepage of water into the oil; and the great ease of inspection and cleaning, are all described in Bulletin No. 904.

Every engineer should send the coupon for a copy.



The Griscom-Russell Co.

2116 West St. Bldg., New York

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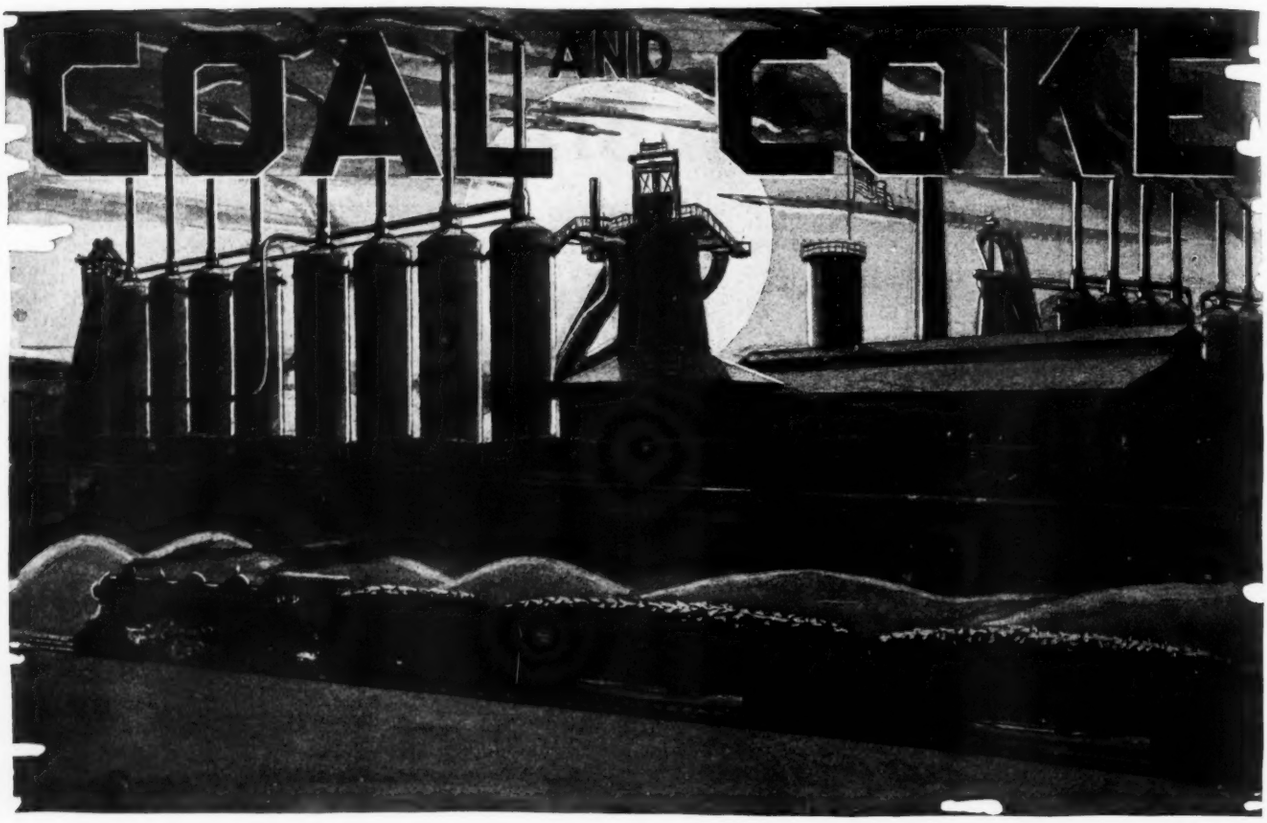


Into the Maw of the Blast-Furnace

The appetite of the modern blast furnace is insatiable and enormous. Such a plant, in addition to the lime and ore, devours daily some 400 tons of coke! In the course of a year the consumption of coke by blast furnaces alone amounts to over forty million tons!

To feed this ravenous appetite is no slight task. Fuel must be on hand at all times. Shortages simply must not occur. If the coke comes from a by-product plant nearby, coal must be supplied to it in immense quantities.

We buy coal and coke and ship it to our customers all over the country, always careful to avoid delays and to use the most direct and economical routes. Our expert traffic department makes this possible.

We can be of service to you, too. Get in touch with us and place your fuel problem before us. We can relieve you of this source of worry and trouble, assuring you a full supply of both coal and coke at all times.

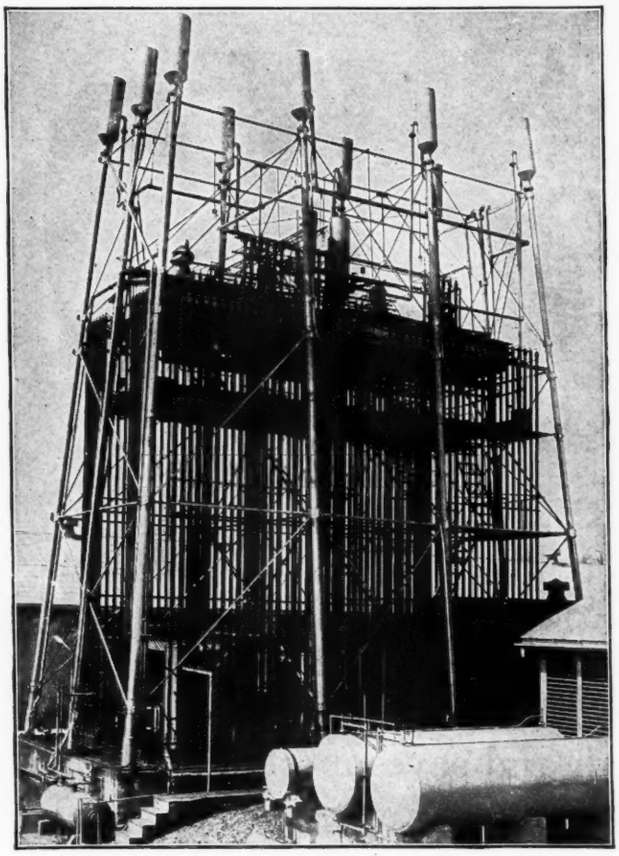
INTERNATIONAL FUEL & IRON CORPORATION

PHILADELPHIA · PITTSBURGH · CINCINNATI

FUEL IRON TRADE MARK

International

Do it with SMOOTH-ON



SMOOTH-ON No. 1 *for* HOT and COLD OIL SCREW-THREAD JOINTS

The following letter from The Bertsch Process Co., Consulting Engineers, of Tulsa, Okla., describes their experience with Smooth-On Iron Cement No. 1 for making perfect hot and cold oil screw-thread joints. The letter is self-explanatory—read it!

"MESSRS. SMOOTH-ON MFG. CO., May 30, 1922
"Jersey City, N. J.

"Gentlemen:—

"In connection with our process of extracting gasoline from natural gas, we use heat-exchangers and stills, of which the latter are directly fired by residue gas.

"The heat-exchangers are formed by vertical pipes, of which a 2-in. pipe is placed within a 3-in. pipe. Through the inner pipe passes oil of from 60 to 160 deg. F., that is to say, the oil of 60 deg. F. enters the pipe at the bottom and leaves it on top with about 160 deg. F. Within the annular space formed by the 2-in. and 3-in. pipes passes hot oil, entering on top at about 450 deg. F. and leaving at the bottom at about 100 deg. F.

"We wish to state that we have used Smooth-On Iron Cement No. 1 for making all screw-thread connections for stills and heat-exchanger joints for both hot and cold oil with wonderful success. We formerly used glycerine and litharge, which did not give satisfaction.

Yours very truly,
THE BERTSCH PROCESS COMPANY,
(Signed) J. C. Bertsch, President.

Once again, Smooth-On Iron Cement No. 1 succeeded in making perfect joints where other methods had failed.

This is only *one* instance where Smooth-On Iron Cement No. 1 proved valuable—hundreds of others are described in the NEW Smooth-On Instruction Book No. 19.

This book, just off the press, is a compilation of the experiences of engineers who have made successful repairs with Smooth-On Iron Cements. It contains 144 pages—and each page illustrates a different power plant repair, described by the engineer who did the work.

Get your copy today—it's Free—mail the coupon.

Smooth-On Iron Cements are sold by Supply Houses in 5-lb., 10-lb. and 25-lb. tins. Also in larger sizes.

SMOOTH-ON MFG. COMPANY
Est. 1895
Dept. 30-Z. Z., 570-574 Communipaw Ave.
Jersey City, N. J., U. S. A.

If your Supply House does not carry Smooth-On Iron Cement, send us their name and we shall see that you are supplied.

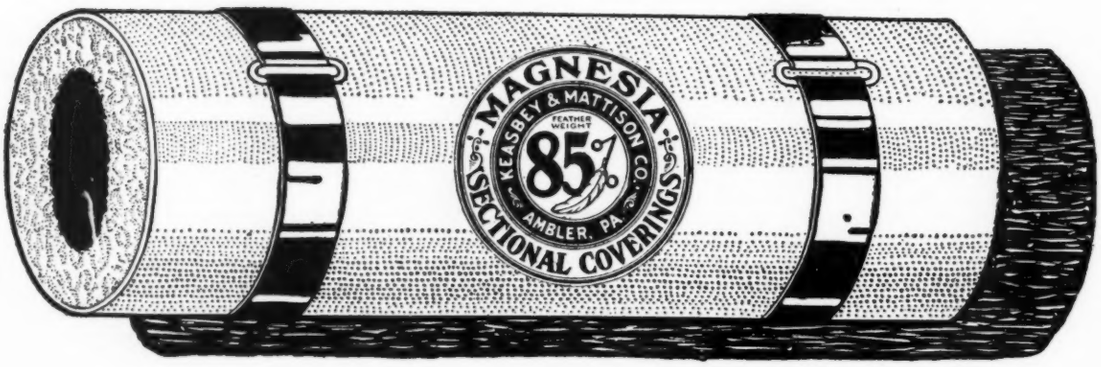
SMOOTH-ON MFG. CO.,
DEPT. 30-Z. Z., JERSEY CITY, N. J.

Gentlemen:—Kindly send me a free copy of Instruction Book No. 19, as per your Dec. 26 advertisement in Power.

Name .....

Address .....

Get the largest amount of air cells in your 85% magnesia pipe covering



This means you will always buy "K & M" 85% Magnesia—the lightest weight "Magnesia" Covering known. "K & M" 85% Magnesia Coverings are made with carefully selected asbestos fiber, which gives the necessary structural strength and saves more coal than other 85% magnesia coverings.

"The Lighter they weigh—
the better they pay"

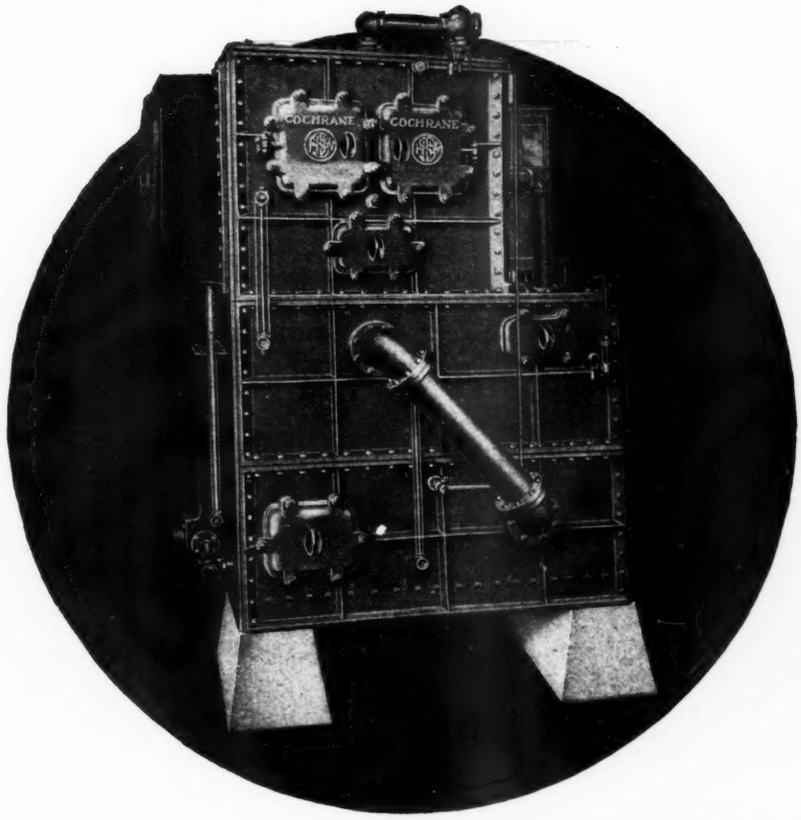
Buy by weight
Get more insulation
Save more coal
Have more dry steam

Address all orders, correspondence, etc:

Keasbey & Mattison Company
Dept. 2, Ambler, Penna.

Atlanta, Ga.	Chicago, Ill.	Minneapolis, Minn.	Pittsburgh, Penna.	Wilkes-Barre, Penna.
Boston, Mass.	Cincinnati, Ohio	New York, N. Y.	Syracuse, N. Y.	Montreal, Canada
Baltimore, Md.	Cleveland, Ohio	Norfolk, Va.	Milwaukee, Wis.	Toronto, Canada
Buffalo, N. Y.	Detroit, Mich.	Philadelphia, Penna.	Washington, D. C.	

Pacific Coast Office: Sharon Bldg., San Francisco
Southwestern Distributor: R. V. Aycock Company, Kansas City, St. Louis, Tulsa, Houston



How One Engineer Saved 30% on His Coal Bill

A LARGE mill in Canada installed a Cochrane Metering Heater. The operating engineer, an intelligent, alert man, made the most of his opportunities in using the metering heater to reduce steam costs and incidentally to increase the value of his job, both to the company and to himself. He feels that the heater has been a prime factor in his own success and believes that an account of how he has used it may be suggestive to other operating men:

To begin with, he installed the meter himself without assistance and made a good job of it. Upon checking up the readings from the metering heater with the meter in the cold water make-up line, he found that about 90% of the boiler feed consisted of make-up which contained some scale-forming matter. By bringing his returns to the Cochrane Metering Heater, he was enabled to collect and utilize most of the returns for boiler feed, thus reducing the amount of make-up to about 45%, and diminishing correspondingly the amount of scale to be removed from the boilers.

The metering heater also condensed exhaust steam from engines and pumps that had formerly been wasted, so that the temperature of the water going to the boilers was increased.

By making use of the charts from the metering heater, he was enabled to see how the boilers were being fed when he was not around, which has resulted in more even feeding of the different boilers.

By using the meter for testing the individual boilers, he was enabled to find which ones were inefficient and to locate and remedy the defects. He also used the meter for testing different lots of coal and has been able to effect considerable savings by telling the management which grades of coal to buy.

Since the metering heater was installed, the coal consumption has been reduced from approximately 13½ tons per day to 9½ tons per day, while the load has slightly increased. The engineer gives the credit for this improvement to the metering heater, although, of course, it has been only through his own diligence and intelligence that such good use has been made of the equipment.

Would you be interested in information showing how you can find and stop waste in your own plant? Ask for special publication L.

H. S. B. W.-COCHRANE CORPORATION

Formerly Harrison Safety Boiler Works

17th and Clearfield Streets, Philadelphia, Pa.

Also at Atlanta, Baltimore, Birmingham, Boston, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Greenville, South Carolina; Hazleton, Pa.; Houston, Indianapolis, Kansas City, Little Rock, Los Angeles, Minneapolis, New Orleans, New York, Pittsburgh, Richmond, Rochester, St. Louis, Salt Lake City, San Francisco, Seattle, Syracuse, Tucson, Toronto Montreal, Halifax.

161

"TO ECONOMIZE-COCHRANIZE"

WE CANNOT ELIMINATE

Vibration

after

The Rotor Has Blown Up

BUT

if you will call us into consultation, as soon as there is any indication of vibration—when the rotor begins to run rough—we can and will locate the trouble and

ELIMINATE THE *Vibration*

caused by lack of balance

While explosions of rotors may be infrequent, and the chance of being the next unfortunate one; as business men, you know that the time to prevent accidents is before they happen.

The cost of prevention is considerably less than that of "making good the damage," even though it only be for property loss.

A field corps of experts can analyze and correct your problems of unbalance, in your plant, with the aid of

NWA Balancing Machine

Five stock sizes, for rotating bodies weighing from 10 lbs. to 150,000 lbs. Special sizes built to meet unusual problems.

Write for booklet "Eliminating Vibrations"

WE SOLVE VIBRATION PROBLEMS

Trade Mark Registered

VIBRATION SPECIALTY COMPANY

N. W. Akimoff, President

Harrison Building

Philadelphia, Pa., U. S. A.

IF YOU CAN'T USE IT

Sell It

The equipment you do not need can usually render good service elsewhere. You can reach the largest group of buyers of such equipment at small cost through an ad in the

SEARCHLIGHT SECTION

For Every Business Want

"Think* SEARCHLIGHT *First"

0155

DE LAVAL STEAM TURBINE CO.

Trenton, N. J.

Steam Turbines, single and multi-stage, geared and directly connected, and for belt and rope drives; for all steam conditions; capacities up to 15,000 Hp. Catalog D40.
Complete Turbo Generator Sets.
Double Helical Speed Reducing Gears for high speed service. Catalog G 40.
Centrifugal Pumps, single and multi-stage, horizontal and vertical shaft, for all heads and capacities. Catalog B40
Centrifugal Blowers and Compressors for all deliveries and all pressures up to 125 lbs. Catalog L 40.

CURTIS

Engineering Specialties

Improved Steam Pressure Regulators, Balanced Steam Traps, Hydraulic Damper Regulators, Temperature Regulators, Water Pressure Regulators. **Write for Catalog No. 50.**

Julian d'Este Company

26 Canal St., Boston 14, Mass.

UNITED CONVEYORS will solve your ASH and SOOT problem

Write for Bulletin describing our many Superior Features

HOLLOW TILE ASH TANKS, UNITED COAL POCKETS

UNITED CONVEYOR CORPORATION

1500 Old Colony Bldg., Chicago, Ill.

Only reliable products can be continuously advertised

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EMPLOYMENT-BUSINESS OPPORTUNITIES-EQUIPMENT

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Power

POSITIONS VACANT

New York

DRAFTSMAN, preferably with designing experience on engines or air compressors; location Ohio. Apply, giving full particulars, P-179, Power, 10th Ave., at 36th St., New York City.

North Carolina

SHIFT engineer wanted for turbine room of 3,000 kw. Curtis turbines, Wheeler surface condensers, Sterling boilers, Murphy stokers; location North Carolina. In reply state age, married or single, experience last three years and salary expected. P-180, Power, Real Estate Trust Bldg., Philadelphia, Pa.

EMPLOYMENT AGENCIES

GENERAL ENGINEERING AGENCY, Fulton Bldg., Pittsburgh, require for general proposals among employers everywhere power managers, mechanical-electrical superintendents, master mechanics, engineers, electricians, draftsmen, foremen erectors, pipefitters, salesmen, chemists, cadets.

EMPLOYMENT SERVICE

SALARIED POSITIONS, $2,500 to $25,000 upward; executive, technical, administrative, engineering, manufacturing, professional, managing, financial, etc., all lines. If you are qualified and receptive to tentative offers for a new connection, you are invited to communicate in strict confidence with the undersigned, who will conduct preliminary negotiations for such positions. A method is provided through which you may receive overtures in confidence without jeopardizing present connections and in a manner conforming strictly to professional ethics. Send name and address only. Preliminary particulars will be sent without obligating or compromising you in any way. R. W. Bixby, Inc., 406 Lockwood Bldg., Buffalo, N. Y.

POSITIONS WANTED

Connecticut

AN OPERATING and maintenance man in large central station is available for an executive position in either central stations or industrials plant; can furnish references; married, thirty-seven years of age; about eighteen years in steam plants. PW-136, Power, 10th Ave. at 36th St., New York City.

Illinois

I. C. S. student of steam-electric engineering, age twenty, single, wants position as oiler in central station; available after Jan. 1, Iowa or northern Illinois preferred; best reference. Carl Parish, Macon, Ill.

POSITIONS WANTED

Indiana

EXPERIENCED operating engineer, I.C.S. graduate in complete steam engineering; nine years' experience with Curtis steam turbine, Corliss engines, water tube boiler; can furnish good reference; age thirty, married. PW-189, Power, Old Colony Bldg., Chicago, Ill.

Michigan

IF YOU can use a thoroughly practical and experienced steam engineer, able to make any kind of layout and well known in Michigan and surrounding territory, with several years' sales experience, address PW-190, Power, Leader-News Bldg., Cleveland, Ohio.

Pennsylvania

AN ENGINEER, with a thorough knowledge of manufacture, installation and operation of power plant prime mover apparatus and auxiliaries, is seeking a position with a reputable utility company of such size as to warrant their retaining a supervising engineer. PW-185, Power, Real Estate Trust Bldg., Philadelphia, Pa.

RESPONSIBLE position wanted by mechanical engineering designer, familiar with pumping, blowing, Corliss engines, centrifugal pumps, general machinery; Philadelphia (Pa.) district preferred. PW-142, Power, Real Estate Trust Bldg., Philadelphia, Pa.

REPRESENTATION AVAILABLE

Rochester Sales Agency

Desires to represent a reputable manufacturer in Rochester and central New York. Address 121 Central Bldg., Rochester, N. Y.

AGENTS AND SALESMEN

Agent Wanted

To sell CoKalite, the perfect protector; stops air leaks, prevents rust and can be used on every boiler setting; 25 per cent commission. Address CoKalite Division, CoKal Stoker Corp., 341 E. Ohio St., Chicago, Ill.

SALESMEN AVAILABLE

TRAVELING salesman desires position with manufacturer of high grade mill supplies; fifteen years' experience in West, South, Mexico and Cuba; familiar with all jobbers and large steam plants in oil field territory and capable of handling jobbers' relations; best of references; salary proposition only. SA-186, Power, Leader-News Bldg., Cleveland, O.

AGENCIES WANTED

Selling Agency

A boiler and engine house of the best reputation and of over twenty years' standing in the New York market desires the selling agency of good power boilers; will finance themselves. A-191, Power, 10th Ave. at 36th St., New York City.

FOR SALE

Indicator

Tabor outside spring type steam engine indicator; never been used, at less than half its cost. For particulars, address T. A. Lawes, 1644 Ansel Road, Cleveland, Ohio.

PATENT ATTORNEY

C. L. Parker, patent attorney, formerly member Examining Corps. U. S. Patent Office, McGill Bldg., Washington, D. C. Inventors' handbook sent upon request.

H. R. T. BOILERS

72 in. x 16 ft. suspension type, 150 hp., 100 lb., made by the Erie Iron Works. Boilers have 9/16 heads, ½ in. triple riveted butt strapped shells, 120 and 135 3-in. tubes, new two years ago. Boilers are complete with fronts, safety valves, gauges, Jones Underfeed Stokers, two engine driven forced draft fans, two boilers, feed pumps, two injectors, feed water regulators and all trimmings. These boilers are being removed to make room for larger units.

Purchasing Agent

The University of Chicago

Chicago, Ill.

Roots Rotary Positive Blowers

5—No. 3 Roots High Pressure, Style D, Blowers, top discharge, with a displacement of 2⅜ cu. ft. per revolution, single geared with double out board bearings on bed plates, 30-in. x 8-in. driving pulleys. Constructed for maximum pressure of 10 lbs. to the sq. inch.

Send for complete specifications

Nashville Industrial Corporation

Jacksonville, Tennessee.

ENGINE

75 to 100 Horsepower

12 x 34-in. "Slater" Engine. Built for 150 lb. steam pressure, 125 r.p.m.

Recently rebored and refitted throughout. Can be seen running until about Feb. 1st, 1923.

Condition Guaranteed

Price $500

H. T. Cushman Mfg. Co.

No. Benington, Vt.

EXECUTIVES

Qualified men—Technical, Commercial and Manufacturing—seeking new positions find our effective and confidential service extremely satisfactory. Our Mr. H. H. Harrison can negotiate a suitable connection for you as he has done for thousands of others since 1909. Inquiries invited; confidences respected.

THE NATIONAL BUSINESS BOURSE, Inc.

Confidential Negotiators

Association Building, Chicago

REPRESENTATIVE WANTED

Manufacturer of high pressure boilers and heating boilers for 50 years, desires representation in Indianapolis, Indiana and Cincinnati, Ohio, and adjacent territory. All correspondence confidential.

AS-188, Power

Leader News Bldg., Cleveland, Ohio.

BUY IT FROM THE NAVY

By sealed bids, opening as follows:

On January 4th, 1923
PIPE FITTINGS

Cat. No. 158-B, in 114 lots, consisting of approximately:

1,291,917	Bushings	67,115	Clamps
1,169,774	Couplings	2,129	Bosses
1,304,569	Elbows	330,980	Caps
89,839	Bends	179,081	Cocks
56,200	Clips		
225	Cesspools	114	Crosses

These fittings are of various styles and patterns; they are made in Iron, Brass, Copper and Composition, and range in size from ¼ to 6 inches, however, the majority are under 2½ inches.

Catalogues on other pipe fittings to follow shortly.

Write or wire for Catalogue No. 158-B, giving full description, sizes, locations and terms of sale, to any Supply Officer.

On January 9th, 1923
SHIP CHANDLERY SUPPLIES

Cat. No. 154-B, in 60 lots, consisting of approximately:

2,020 Motor Boat Bells, 9¾ in. diam.
23,960 Boat Fenders (cork and rope)
101,671 Sounding Leads, 5-80 lb.
540 Jacks, capacity 7-100 ton
2,121 Wooden Masts, 14-37 ft. long
15,383 Straight Oars, 8-18 ft. long
1,077 Blacksmiths' Anvils (25-300 lb.)

Write or wire for Catalogue No. 154-B, giving full description, sizes, locations and terms of sale, to any Supply Officer.

On January 10th, 1923
COALING BUCKETS

Cat. No. 160--B, in 5 lots, consisting of approximately:

30—Clam Shell Buckets, Hayward Class "E." Cap. 1 and 1⅝ cu. yd.
3—Clam Shell Buckets, Orton & Steinbrenner, Type "V." Cap. all 1¼ cu. yd.
3—Clam Shell Buckets, Mfg. by Williams. Cap. all 0.8 cu. yd.
30—Clam Shell Buckets, Meade-Morrison, Type "BL." Cap. all 1 1/5 cu. yd.

These coaling buckets are all located at the Navy Yard, Norfolk, Va.

Write or wire for Catalogue No. 160-B, giving full description, sizes, and terms of sale, to any Supply Officer.

Prospective purchasers are invited to communicate with the undersigned or any of the following Supply Officers, who will furnish any or all of the catalogues and also arrange for inspection of materials.

Supply Officers at Navy Yards:

(1) Boston, Mass. (2) Norfolk, Va. (3) Philadelphia, Pa. (4) New York, N. Y. (5) Mare Island, Calif. (6) Puget Sound, Wash. (7) Naval Training Station, Great Lakes, Ill. (8) Board of Survey, Appraisal and Sale, Navy Supply Depot, So. Brooklyn, New York.

Bids on all of the above sales should be plainly marked, addressed to, and must be actually delivered to the undersigned prior to 11:00 A.M., on the date of opening, where they will be publicly opened at the time designated.

U. S. NAVY CENTRAL SALES OFFICE
Navy Yard, Washington, D. C.

D. C. ENGINE GENERATOR SETS

1—50-kw., 250-v., 280 r.p.m., Gen. Elec., D.C. generator, mounted on sub-base and direct connected to 1—11½ x 12 Skinner automatic steam engine, complete with switchboard.

1—100-kw., 250-v., D.C., 250 r.p.m., Bullock cp. wd. generator, dir. conn. to 1—A. L. Ide & Sons, 14 x 14, simple automatic steam engine, complete with switchboard.

1—150-kw., 280 r.p.m., 250-v., D.C., cp. wd., Burke, 3-wire generator set, consisting of 2—75-kw., 125-v., D.C., 280 r.p.m., cp. wd. Burke generators, dir. conn. to 1—240-hp., 14 x 16 Fleming Harrisburg steam engine, complete with all accessories, including swbd.

MOTOR GENERATOR SETS

1—100-kw., 250-v., D.C. General Electric synchronous converter with 2200-v., high tension, 3-ph., 60-cy. transformer, complete with switchboard and all accessories.

1—150-kw., 125/250-v., D.C., cp. wd., Westinghouse rotary converter, complete with transformer for 2200 v., high tension, 3 ph., 60 cy., 187 v. low tension, with starting taps, complete with starting equipment and std. D.C. generator panel.

We also carry a large stock of A.C. and D.C. Motors up to 200 Hp.

Send us a list of what you have to sell

Duquesne Electric & Mfg. Co.
Pittsburgh, Pa.

SURE RENEWED MOTORS BONDED — SURETY MOTORS BONDED

Surety Motor Bonding Co., Licensees

USED OIL ENGINES

20, 35, 40, 50, 60, 85, 100, 120, 140, 150, 200, 225, 280 and 500 H.P. used oil engines in good condition. Write for prices.

ROBERT P. KEHOE
7 East 42nd St., New York City
Telephone Vanderbilt 9595

NEW BOILERS

7—300 hp., B. & W., 200 lb.
4—150 hp., Return Tubular

MOTORS

We have an enormous stock of standard makes at low prices.

Send for our 42-page catalogue, covering every kind of motor or generator used.

We offer only our own material.

George Sachsenmaier Co.
930 N. 3rd St., Philadelphia, Pa.

FOR SALE

Two Vertical Tubular Manning Boilers

Age 13 years, Diam. of shell 74 in., will pass Mass. inspection up to 125 lb., including one Climax Smoke Preventer complete. This is a complete separate plant and under forced draft, boilers will develop 550 hp.

LEVER BROTHERS COMPANY
Cambridge, 39 Mass.

Immediate Delivery
Steam Turbos, 60-cy., 3-ph., etc.

NEW 12,500-kva., 11,500-2300-v. Turbo.
5000-kw., 2300-v. Turbo—80% P.F.
1560 kva., NON-COND., 600-480 v.
250- & 625-kva. Non.-Cond., 240-480-2300 v.
780-kva., 480-2300-v. MIXED PRESS. TURBOS.
800- and 1000-kw., D.C., 250-125-v. Turbo.
1560-1250-625-kva. FREQ. CHANGERS.
400-150-75-50 kw. Eng. Sets, 275 v., D.C.
437-625-kva. SIMPLE CORLISS—240-480-v., 3 hp.
NEW 25 & 35-kw. TURBO EXCITERS, Bargains.
937-kva., 2300-v., 3-ph., 60-cy. Comp. Eng. Set.
2—NEW 1000-hp. STERLING BOILERS, 275 lb.
5—1043-hp. EDGEMOOR BOILERS, 200 lb.
2—400-hp. Edgemoor, 175 lb., with Stokers.
4—NEW 290-hp. B. & W. BOILERS, 200 lb.
NEW 1460-cu. ft., 5320-ft. 2-Stage AIR COMPS.
20—Boiler Feed Pumps, Turbo & Motor drive.
ROCK CRUSHERS, CONTRACTORS' EQUIP., BELTED GEN., ETC. *Send us your inquiries*

ROSS POWER EQUIPMENT CO.
Indianapolis, Ind.

Ridgway Motor Generator Set

400 kw., 250 v., D.C. Interpole Generator, direct connected to a 625-hp., 2300-v., 3-ph., 60-cy., 1200 r.p.m. Ridgway Slip Ring Motor and Auto. Voltage Regulator. In use 6 mos., original cost $18,600. Our price, $6,000.

THE GLOW ELECTRIC COMPANY
Cincinnati, Ohio.

FOR SALE

2000 KW. Steam Turbo Generator Unit

Ridiculously Low Price

1—2000-kw. Westinghouse, horizontal, 3 ph., 60 cy., 11000/2300 v., 1200 r.p.m., 150 to 200 lbs. steam pressure, single flow; complete with Condenser, pumps, exciter and switchboard. Cabable of carrying 50 per cent overload continuously. Suitable for water power standby, or can be used as synchronous condenser.

Let us send you a complete list of Power Machinery.

TIPPINS & SPRENGLE
Oliver Building, Pittsburgh, Pa.

MAC GOVERN & COMPANY INC. POWER MACHINERY

114 Liberty Street — New York, N. Y.

Turbo-Generator Units—60 Cycle

500 kw. Allis-Chalmers, non-condensing, 480 volts, 3600 r.p.m., 140 lbs. steam, 5 lbs. back pressure, with dir. conn. exciter and complete switchboard equipment.
500 kw. Westinghouse-Parsons, condensing, 2400 volts, 3600 r.p.m., 170 lbs. steam, 28-in. vacuum, with dir. conn. exciter, switchboard equipment and condenser with accessories.
500 kw. General Electric-Curtis, condensing, 480 volts, 3600 r.p.m., 135-150 lbs. steam, with dir. conn. exciter.
650 kw. Westinghouse-Parsons, condensing, 440 volts, 3600 r.p.m., 150 lbs., steam pressure, with turbine driven exciter and condenser.
1000 kw. Westinghouse-Parsons, condensing, 2300 volts, 3600 r.p.m., 175 lbs. gauge at throttle.
1000 kw. Allis-Chalmers, condensing, 6600 volts, 1800 r.p.m., 150 lbs. steam, parallel flow, reactance type, with dir. conn. exciter, switchboard, condenser and auxiliaries.
1200 kw. Allis-Chalmers, non-condensing, 480 volts, 3600 r.p.m., 150 lbs. steam, 5 lbs. back pressure, with dir. conn. exciter.

A. C. ENGINE-GENERATOR UNITS

100 kva. Westinghouse, 2 ph., 60 cy., 240 v., 277 r.p.m., dir. conn. to 13-in. x 15-in. Skinner side crank engine, with belted exciter and complete switchboard.
125 kva. Crocker-Wheeler, 3 ph., 60 cy., 2300 v., 257 r.p.m., dir. conn. to 11-in. and 22-in. x 14-in. Watertown T.C. engine, with dir. conn. exciter and switchboard equipment.
150 kw. Allis-Chalmers, 3 ph., 60 cy., 2300 v., 225 r.p.m., dir conn. to 19-in. x 20-in. Skinner Universal uniflow engine.
200 kva. Allis-Chalmers, 3 ph., 60 cy., 240 v., dir. conn. to 15 in. x 16-in. Chandler & Taylor engine.
312 kva. General Electric, 3 ph., 60 cy., 2300 v., 120 r.p.m., dir. conn. to 20-in. x 36-in. Murray-Corliss rolling mill type engine, with belted exciter.
500 kw. Westinghouse, 3 ph., 60 cy., 2300 v., 120 r.p.m., dir. conn. to 26-in. x 42-in. Hamilton-Corliss engine.

Also Motor-Generator Sets, Boilers, Pumps, etc. Wire for Prices.

Please Examine this List

GENERAL EQUIPMENT

For Immediate Disposal at Extremely Low Prices

Accumulators—42 in. x 11½ x 50 in. Hydro-Pneumatic.
Blowers—Exhaust, Conoidal, Column, Reversible Mill Exhausters, Pressure, Roots, and Connersville.
Boilers—823 hp. Sterling.
Coal Crushing Rolls—Capacity 150 tons per hour, crushes 1¼ inches and smaller, size 36 inches x 36 inches.
Compressors—15 and 26 x 20 x 24 Compound Duplex Laidlaw, Dunn-Gordon.
Corliss Engines—Allis-Chalmers Heavy Duty 18 in. x 36 in.—350 hp.
Fans—Buffalo Forced Draft.
Heaters—Webster and Patterson—Allen Feed Water Heaters.
Machine Tools—Lathes, Hammers, Grinders, Pipe Cutters and Threaders, Buffers, Tool Stands, Wire Stitcher.
Motors—7½ hp.—75 hp., 60 cycle, 3 phase, 440 volt, General Electric, Westinghouse and Allis-Chalmers.
Pipe—Standard Black 1¼ inch—16 inch.
Cast Iron Class C, 4 inches—12 inches.
Pumps—Boiler Feed, Steam Actuated Hydraulic, Centrifugal, Duplex Steam and Diaphragm.
Railway Equipment—Standard Gauge 60 ton Locomotive, 15 ton Locomotive Crane, Narrow Gauge Storage Battery Locomotives and Cars, Bumping Posts, Rail.
Send for Bulletin No. 12.
Scales—Capacities 600 lb.—100 tons.
All have recently been tested by a scale expert.
Tanks—All Sizes, Steel and Wood.
Bulletin No. 7 will give you Specifications.
Transformers—Westinghouse and General Electric 37½ Kva.—600 Kva.

Consider Us on Your Requirements

Nashville Industrial Corporation

Jacksonville, Tennessee

GUARANTEED

Plant Equipment

Immediate Delivery!

MOTORS AND GENERATORS

7—Westinghouse 250-hp. Motors. Type CCL, 440-v., 60-cy., 3-ph. motors, speed 514 r.p.m., with base and starters. Can be furnished with pulley or flange couplings.
1—60-kw. Triumph Generator, 125-v., D.C., belted.
1—300-kw. G. E. Rotary Converter, 25-cy.
1—250-kw. Gen. Elec., 2300-440 v., 3 ph., 60 cy., direct connected to McEwen compound engine.
1—210-kw. Gen. Elec., 2300-440 v., 3 ph., 60 cy., direct connected to cross compound engine.
1—50-kw. Ft. Wayne, 115-125 v., direct current, direct connected to Ball Auto Engine.
1—35-kw. Burke Elec., 125 v., direct current, direct connected to Ames Auto Engine.
1—50-hp. Allis-Chalmers Induction Motor, continuous duty, 440 v., 3 ph., 60 cy., speed 965, 40 degrees. Complete with Cutler-Hammer starting; controller, oil circuit breaker, base and 14-in. x 9-in. belt pulley.
1—50-hp. Allis-Chalmers Induction Motor, 440 v., 3 ph., 60 cy., speed 1160, 40 degrees, with potential starter, base and 12-in. x 8-in. belt pulley.
1—40-hp. Allis-Chalmers Induction Motor, 440 v., 3 ph., 60 cy., speed 865, 40 degrees, with potential starter, base and 14-in. x 9-in. belt pulley.

PUMPS

1—16-in. x 8½-in. x 12-in. Duplex Steam.
1—14-in. x 10¼-in. x 10-in. Duplex Steam.
1—12-in. x 7-in. x 10-in. Duplex Steam.
1—10-in. x 6-in. x 10-in. Duplex Steam.
3—6-in. x 4-in. x 6-in. Duplex Steam.
4—5¼-in. x 3½-in. x 5-in. Duplex Steam.
2—4½-in. x 3¾-in. x 4-in. Duplex Steam.
1—8-in. x 8-in. Deane Triplex Single Acting Power Pump.
1—Kingsford Horizontal Centrifugal Water Pump, 24-in. suction, 24-in. discharge.
1—Platte Iron Works Horizontal Centrifugal Water Pump, 14-in. suction, 12-in. discharge.
1—Fulton Horizontal Centrifugal Water Pump, 12-in. suction, 10-in. discharge.

Send for a free copy of Bulletin No. 205, describing our complete stocks of Machinery and Equipt.

HARRIS BROS. CO.

35th and Iron Sts., Chicago, Ill.

USED POWER EQUIPMENT

Released from service by a number of public utility companies

Electrical—Hydraulic—Mechanical

Our summary contains a complete list of equipment under above classification

WRITE TODAY FOR YOUR COPY B

Phoenix Utility Co., 71 Broadway, New York City

BRAND NEW

Centrifugal Pumps

LEA-COURTENAY Horizontal Split Case, having brass fittings, arranged for belt drive.

1—3-in., guaranteed for 70 gal. per min., 60-lb. or 140-ft. head, 8½-hp. required, 1600 r.p.m.
1—3 in., 2 stage. Guaranteed for 200 gal. per min., 80-lb. pressure or 185-ft. head, 22-hp. required, 1500 r.p.m.

CHAS. F. AMES & CO.

90 West St., New York City.

Power Machinery Exchange

1 Montgomery Street, Jersey City, N.J.

A. C. Direct Connected Units
3-Phase, 60-Cycle

Kva.	*Generator*	*Engine*
650	Allis-Chal.	Allis-Chal.-Corliss
625	Westghse.	Parsons Hor. Turbine
525	Allis-Chal.	Allis-Chal.-Corliss
500	Westghse.	Parsons Hor. Turbine
400	Westghse.	Parsons Hor. Turbine
400	Allis-Chal.	Allis-Chal.-Corliss
360	Gen. Elec.	Harris Comp. Corliss
340	Westghse.	Harrisburg, 4-valve
300	Gen. Elec.	Allis-Chal.-Corliss
250	Allis-Chal.	Hamilton Non-releasing
250	Westghse.	Chuse, 4-valve
240	Gen. Elec.	Harrisburg, 4-valve
200	Westghse.	Erie Ball, side crank
187	Westghse.	Parsons Hor. Turbine
165	Westghse.	Erie Ball
150	Gen. Elec.	Harrisburg, 4-valve
135	Westghse.	Harrisburg, 4-valve
125	Gen. Elec.	Curtis Hor. Turbine
100	Cr.-Wheeler	Harrisburg
75	Gen. Elec.	Skinner
50	Westghse.	Skinner

A. C. Belted Generators
3-Phase, 60-Cycle

Kva	*Make*	*Speed*
800	Allis-Chal., 3 Brg.	360
500	Allis-Chal.	600
400	Gen. Elec.	600
375	Gen. Elec.	450
360	Westghse.	360
350	Gen. Elec., 3 Brg.	514
312	Gen. Elec.	450
275	Westghse.	450
250	Gen. Elec.	600
225	Allis-Chal.	600
200	Westghse.	600
170	Gen. Elec.	400
150	Gen. Elec.	600
120	Westghse.	900
100	Gen. Elec.	900
75	Gen. Elec.	900
50	Gen. Elec.	1200
40	Elec. Mchy.	1200
35	Cr.-Wheeler	1200
30	Westghse.	1200
20	Fairbanks-Morse	1800
15	Fairbanks-Morse	1800

Direct Current Units
220-250-Volt

Kw.	*Generator*	*Engine*
400	Gen. Elec.	Buckeye Comp.
300	Cr.-Wheeler	Watts-Campbell-Corliss
300	Westghse.	Lane Bodley Corliss
250	Ridgway	Ridgway, side crank
250	Cr.-Wheeler	Harrisburg
200	Gen. Elec.	Erie, 4-valve
150	Gen. Elec.	Ames Uniflow
150	Westghse.	Hewes-Phillips-Corliss
150	Ridgway	Ridgway
100	Allis-Chal.	Skinner
75	Westghse.	Ridgway
75	Gen. Elec., 3-wire	Ridgway
60	Gen. Elec.	Ball
50	Gen. Elec.	Harrisburg
37 ½	Westghse.	Skinner

Direct Current Generators and Motors
220-250-Volt

Hp.	*Make*	*Speed*
250	Elec. Mchy.	250
200	Westghse.	450
150	Cr.-Wheeler	525
120	Gen. Elec.	550
95	Cr.-Wheeler	700
90	West. Elec.	750
75	Gen. Elec.	700
60	Gen. Elec.	750
50	Westghse.	509

Direct Current Units
110-125-Volt

Kw.	*Generator*	*Engine*
250	Gen. Elec.	Harrisburg, 4-valve
200	Gen. Elec.	Harrisburg, 4-valve
200	Westghse.	Harrisburg, 4-valve
150	Gen. Elec.	Buckeye hvy. duty
100	Gen. Elec.	Harrirburg, 4-valve
100	Gen. Elec.	Harrisburg, 4-valve

75—50—35—25—20—15—10-kw. Units in Stock.

BELOIT IRON WORKS
BELOIT, WIS.

EQUIPMENT FOR SALE

If interested wire for particulars

14 x 36 E. P. Allis-Corliss Engine, single cylinder, bolted flywheel.
11 x 12 Ball Engine, automatic self-oiling center crank, direct connected to Northern Electric Generator, 250 v., 150 amp., 37.5 kw., speed 320 r.p.m.
75-hp. Westinghouse style M.P. Generator, 250 v., 850 r.p.m.
40-kw. Northern Electric Generator, 160 amp., speed 650 r.p.m., 250 v. D.C.
45-kw. Holtzer Cabot Electric Co. Motor, type M.P., 250 v., 170 amp., speed 1100 r.p.m.
30-kw. Motor Generator Set, composing of 46-hp., 3-ph., 60-cy., 220-v. A.C. Motor, direct connected to 30-kw., speed 1200 r.p.m., kw., 250v., D.C. Generator, 2 wire. Generator Set, above complete with type J.D.D.C. generator, 16 x 48 panel with circuit breaker type SL Westinghouse ammeter and voltmeter plug, rheostat, switches, etc. on a pipe frame with auto starter for A.C. motor.
One Thompson Ryan, 15 hp., 230 v., speed 850 r.p.m., D. C.
Two Northern 15 hp., 230 v., speed 750 r.p.m., D.C.
One General Electric type C.E., no armature, winding or commutator.
One set Western Electric Wall and Desk Inter-communicating Telephones, 17 stations.
One reel containing approximately 400 ft., one million C. M. Habershaw R. C. D. B. Cable on original reel.
Three pole single throw back connected switches, type A.
One 800 amp., 250 v.
One 200 amp., 250 v.
One 400 amp., 250 v.
One 300 amp., 250 v.
Two pole single throw back connected switches.
Two 500 amp., 250 v.
Single pole air circuit breakers, back connected.
1—Westinghouse type CC, 800 amp., 250 v.
4—Westinghouse type CC, 300 amp., 250 v.
1—Westinghouse type CC, 600 amp., 250 v.
1—ITE single pole 200 amp., 250 v.
1—Roller Smith 150 amp., 250 v.
Weston Model No. 57 Meters.
1.....0.....150 amp.
2.....0.....200 amp.
1.....0.....400 amp.
Thompson Astatic.
1.....0.....350 v.
1.....0.....800 amp.
A. C. Ammeters.
One Westinghouse, 120 amp.
17-in. belt, Trip.
14-in. belt, Trip.
10-in. belt, Trip.
All good condition.
One Bond Boring Mill, 62-in. diameter, table 81-in. diameter, swing between housings, 46-in. height from table to under side of rail, 5 set cone pulley drive.
One Pond Planer, 60 in. x 16 ft. 0 in., 48 in. height under rail, two heads on rail, belt drive.

Water Tube Boilers

250 to 1000 H.P.—Immediate Delivery!

New Water Tube Boilers, built for pressures of 200 lbs. and 225 lbs., ready for immediate delivery from Chicago, Dumont, New Jersey, opposite New York City, or Slidell, Lousiana, near New Orleans.

Our low prices present a saving of from 25% to 50%. We will take in your old equipment on a liberal exchange basis.

Write for our new catalog fully describing our boilers. Your copy will be mailed on request.

HARRIS BROTHERS COMPANY
West 35th and Iron Sts., Chicago

EXCITERS

2—G. E., 100-kw. Curtis Turbo Exciters. Turbine, 3600 r.p.m., 75-150 lbs. pressure, Form C, non-condensing Generator, compound wound, type R.C.-17, Form A, 800 amp., 125 v., D.C., 1200 r.p.m.

1—G. E., 75-kw., Motor Driven Exciter. Motor 115-hp., 25 amp., 3-ph., 60-cy. Generator, compound wound, Form A. Type R.C.-16, 600 amp., 125 v., D. C., 1200 r.p.m.

Practically new condition. Complete specificaitons sent gladly upon request.

Nashville Industrial Corporation
Jacksonville, Tennessee.

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80 to 1000 Horsepower

ENGINE GENERATORS

25 kw. to 350 kw. All Voltages.

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75 kw. to 1000 kw. All Voltages.
Compressors—Engines (Oil, Gas, Steam), Condensers—Pumps, etc.

Write for price and complete specifications.

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300-kw., Allis-Chalmers, 250-v. D.C. to 18 x 36 Heavy Duty Corliss Engine, 125 r.p.m.

G. E.—Curtis Turbo Sets

100 kw., 250 v., 2400 r.p.m., 125-lb. press.
75 kw., 250 v., 2400 r.p.m., 150-lb. press.
25 kw., 125 v., 3600 r.p.m., 175-lb. press.
10 kw., 125 v., 5000 r.p.m., 200-lb. press.

MARVIN BRIGGS, INC.
167 Sixth St., Brooklyn, N. Y.

Equipment for Power House

Exceptional Prices Quoted on This Surplus Stock

823 H.P. BOILERS AND ACCESSORIES

35—823 hp. Class M-30 Babcock and Wilcox Sterling Boilers. 200 lb. pressure. 630 3¼ in. No. 10 gauge tubes. Drums, double riveted, double strap butt joint. Space occupied by boiler, 18 ft. wide by 23 ft. deep by 29 ft. 9 in. high,

Soot Blowers—Vucan, 6 elements.

Non-return Valves—Foster, 8 in.

Safety Valves—Consolidated, nickel seat.

Flow Meters—Bailey, Type D-25, Class 56.

Steam Gauges—Ashcroft, 12 in.

Stokers—8 Retort Westinghouse underfeed double dump, complete with transmission.

Stoker Drive Engines—Buffalo, 8 in. x 8 in., Type "A" vertical, with throttling governor, Morse silent chain drive.

Forced Draft Fan—Buffalo, Type TD 9½ conoidal fan, direct connected to 225 max. hp. Moore Steam Turbine and reduction gear. Capacity 110,000 cu. ft. at 6 in. static head.

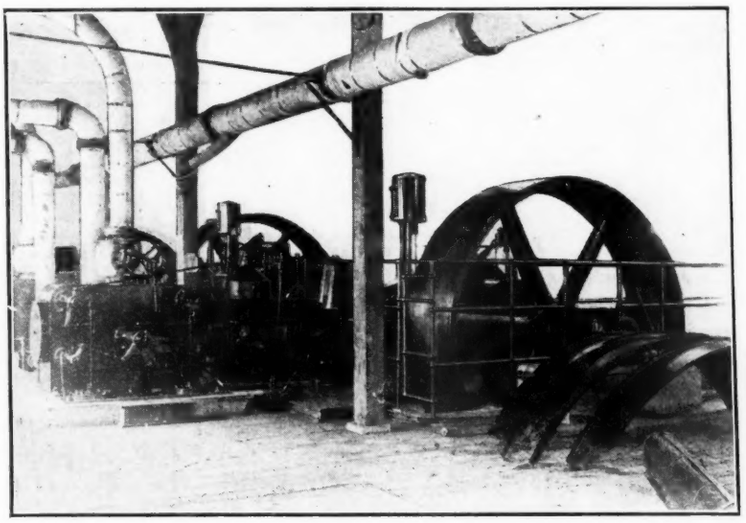
All boilers operated less than 90 days.

FEED WATER HEATERS

4—Webster, Class B, Open Feed Water Heaters. Capacity 11,000 B. H. P., size 10 ft. 5 in. high x 9 ft. 10 in. wide and 8 ft. 7 in. deep.

8—Patterson - Allen Closed Water Heaters. Capacity 30,000,000 B.T.U. per hour, 470 gallons water per minute, size 44 in. diameter x 10 ft. 2 in. long.

6—Patterson - Allen Closed Water Heaters. Capacity 8,000,000 B.T.U. per hour, 126 gallons water per minute, size 24 in. diameter x 8 ft. 6 in. long.



PUMPS

Motor Driven Centrifugal

8—14-in. Worthington, Class B double suction 8500 G.P.M. at 152-ft. head, direct connected to 300-hp., G.E. 3-ph., 60-cy., 2200-v Motors.

Steam Turbine Driven Centrifugal

6—16-in. Allis-Chalmers Type S, 8500 G.P.M. at 90-ft. head, direct connected to 3-stage, Type L, 300-hp., 2000 r.p.m., G.E. Curtis Steam Turbine.

16—14-in. Allis-Chalmers Type S, 6500 G.P.M. at 150-ft. head, 8100 ft. at 90-ft. head, direct connected to 3-stage, Type L, 300-hp., 2000 r.p.m. G.E.-Curtis Steam Turbine.

PUMPS (Continued)

Steam Actuated Hydraulic

100—New and used 2½-, 3 in., 4 in., 5 in., and 6 in. Belt driven centrifugal pumps.

5—14 and 20 x 7½ x 18-in. Worthington Compound Duplex outside packed plunger pot valve, 400 G.P.M. at 300 lb. pressure.

8—25 and 38 x 4⅝ x 24-in. Worthington Tandem Compound Duplex, outside packed, 150 G.P.M. at 3600 lb. pressure.

200—New and used Simplex and Duplex, steam driven Worthington Pumps, 4½ x 3¾ x 4, 5¼ x 4⅝ x 5, 6 x 2½ x 6.

CORLISS ENGINES

18—**Allis-Chalmers Heavy Duty Mill Type** Corliss Engines. Double eccentric, size 18 in. x 36 in. crown face fly-wheel 11 ft. diameter by 37 in. face. At 125 r.p.m., 140 lb. pressure at throttle and not exceeding 1½ lb. back pressure. Non-condensing. Mfrs. I.H.P. ratings as follows:

21% Cut off 355 H.P. **60% Cut off 595 H.P.**
30% Cut off 435 H.P. **75% Cut off 640 H.P.**
42% Cut off 525 H.P.

Full load steam consumption—22 lb. per I.H.P. Engine complete with Richardson-Phenix oil filtration and lubricating system. Both right and left hand types available.

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Belted and Direct Connected

1—5000-kw. General Electric Vertical, 3-phase, 60-cycle, 4500-volt Turbo Generator Set, with condenser and accessories.
1—1200-kw. General Electric, 3-phase, 60-cycle, 250-volt Generator, direct connected to Filer & Stowell, cross compound, Corliss Engine.
1—600-kw. General Electric, 3-phase, 60-cycle, 250-volt Generator, direct connected to an 18 x 42 x 36 Filer & Stowell Corliss Engine.
1—500-kw. Westinghouse, 3-phase, 60-cycle, 2300-volt Generator, direct connected to a 26 x 42 Hamilton Corliss Engine.
1—350-kw. Westinghouse, 3-phase, 60-cycle, 220-volt Generator, direct connected to a 26 x 42 Murray Corliss Engine.
1—300-kw. General Electric, 3-phase, 60-cycle, 2300-volt Turbo Generator Set, condensing.
1—250-kw. Westinghouse, 3-phase, 60-cycle, 220-volt Alternator, direct connected to a 22 x 42 Murray Heavy Duty Corliss Engine.
1—250-kva. Allis-Chalmers, 3-phase, 60-cycle, 2300-volt, 600-r.p.m. belted type Alternator.
2—200-kw. each, DeLaval-Bullock, 3-phase, 60-cycle, 220-440-volt Turbo Generator Sets, with condensers and accessories.
1—125-kva. Ft. Wayne, 3-phase, 60-cycle, 1150-2300-volt Generator, direct connected to a 15 x 16 Erie-Ball Automatic Engine, with accessories.
1—100-kw. General Electric, 3-phase, 60-cycle, 220-volt, 3600-r.p.m. Turbo Generator Set, with condenser and accessories.
1—62½-kw. Lincoln, 3-phase, 60-cycle, 480-volt Generator, direct connected to an 11 x 12 Chandler & Taylor Automatic Engine.

D. C. GENERATORS
Belted and Direct Connected

1—510-kw. Crocker-Wheeler, 300-volt, compound wound Generator, direct connected to a 19 x 40 x 36 McIntosh & Seymour Engine.
1—300-kw. Triumph, 250-volt, compound wound Generator, direct connected to a 15 x 28 x 30 Hamilton Cross Compound Corliss Engine.
—250-kw. Triumph, 125-volt Generator, direct connected to a 22 x 20 Skinner Automatic Engine. (Can be rewound for 250 volts.)
2—150-kw. Westinghouse, 275-volt, 200-r.p.m. Generators, each direct connected to an 18 x 19 Fleming-Harrisburg Automatic Engine.
1—125-kw. Fort Wayne, 230-volt, compound wound Generator, direct connected to a 17 x 16 Skinner Automatic Engine.
1—100-kw. Triumph, 125-volt, 675-r.p.m., compound wound, belted type Generator.
1—75-kw. Ft. Wayne, 250-volt, compound wound Generator, direct connected to a Skinner Automatic Engine.
1—38½-kw. Western Electric, 250-volt, compound wound Generator direct connected to a x 12 Skinner Engine.
1—35-kw. Triumph, 125-volt, compound wound, Generator, direct connected to a 9 x 12 Skinner Automatic Engine.
1—22½-kw. Allis-Chalmers, 120-volt, 187.5 amps. 925-r.p.m., compound wound, belted type Generator.
1—20-kw. Western Electric, 1250-r.p.m., 120-volt, compound wound, belted type Generator.
1—17½-kw. Triumph, 125-volt, 140-ampere, 1250-r.p.m., compound wound, belted type Generator

BOILERS

6—1040-hp. Edgemore, ASME code, 200-lb pressure.
8—520-hp. Stirling, 175-lb. pressure.
3—250-hp. Franklin, Heine type, 150-lb. pressure.
3—207-hp. Geary, Heine type, 175-lb. pressure.
2—175-hp. Atlas, 150-lb. pressure.
1—175-hp., 78 x 18, high pressure, H.R.T.
4—150-hp., 72 x 18, high pressure, H.R.T.
5—125-hp., 72 x 16, high pressure, H.R.T.
2—100-hp., 66 x 16, high pressure, H.R.T.
2—100-hp., 66 x 16, Standard, H.R.T.
1— 80-hp., 60 x 16, high pressure, H.R.T.
1— 60-hp., 54 x 14, high pressure, H.R.T.
1— 50-hp., 48 x 120, high pressure, Vertical.
1— 75-hp., high pressure, Fire Box.
1— 40-hp., high pressure Fire Box.
2— 25-hp., 42 x 95, new Vertical, 125-lb. pressure.
1— 15-hp., 36 x 83, new Vertical, 100-lb. pressure.
1— 10-hp., 30 x 83, new Vertical, 100-lb. pressure.

STEAM ENGINES

1—26 x 48 Vilter left-hand Corliss.
1—17 x 34 x 48 Hamilton Corliss Compound, heavy duty, Corliss, designed for rope drive.
1—22 x 42 Hamilton heavy duty Corliss.
1—22 x 42 Allis heavy duty Corliss.
3—18 x 36 Allis-Chalmers, heavy duty, Corliss.
1—16 x 16 Lane & Bodley Slide Valve.
1—14 x 18 Erie City Iron Works Automatic.
1—13 x 16 Erie City Iron Works Automatic.
1—13 x 16 Chandler & Taylor Slide Valve.
2—10 x 12 Valley Iron Works Automatic.
1—10 x 12 Chandler & Taylor Slide Valve.
1— 9 x 12 Skinner Automatic.

Also many other sizes.

MOTOR GENERATOR SETS

2—500-kw. Westinghouse, 250-volt, D.C., 720-hp.; 3-phase, 60-cycle, 2300-volt Synchronous Motor Generator Sets.

ROTARY CONVERTERS

2—200-kw. Westinghouse, 250-volt, D.C., 3-phase, 60-cycle, Rotary Converters.

A. C. MOTORS
3-Phase, 60-Cycle
Squirrel Cage and Slip Slip Ring

No.	*Hp.*		*Make*	*Volts*	*Rpm.*
12	7½	New	General Electric	220	1800
6	10	New	General Electric	220	1200
2	15	New	Fairbanks-Morse	440	1750
5	15	New	General Electric	220	1200
1	20	Used	Fairbanks-Morse	220	1200
5	20	New	General Electric	220	1200
5	25	New	General Electric	220	1200
1	25	New	G. E. (Slip Ring)	220	1200
3	30	New	General Electric	220	1200
4	40	New	General Electric	220	1200
4	50	New	General Electric	220	900
1	50	Rebuilt	General Electric	220	900
3	50	New	G. E. (Slip Ring)	440	900
3	75	New	G. E. (Slip Ring)	220	900
3	100	New	G. E. (Slip Ring)	220	900
1	100	Rebuilt	Westinghouse	220	1200
2	150	New	G. E. (Slip Ring)	440	720
1	200	Used	General Electric	2200	514
1	250	New	A.-C. (Slip Ring)	2200	514
1	275	Used	G. E. (Slip Ring)	240	600
1	960	New	G. E. Synchronous	550	720

Also many other sizes and types.

Any of the above 220 volt motors can be furnished for 440 volt, or vice versa.

D. C. MOTORS

No.	*Hp.*		*Make*	*Volts*	*Rpm*
1	50	Rebuilt	Allis-Chalmers	250	800
1	40	Rebuilt	Jantz & Leist	250	800
3	30	Used	Jantz & Leist	250	600
1	20	Rebuilt	Triumph	250	965
1	15	Rebuilt	Minneapolis	110	350
1	12½	Rebuilt	Minneapolis	220	950
1	7½	Rebuilt	Jantz & Leist	220	800
2	5	Rebuilt	Triumph	220	1352
1	5	Rebuilt	Jantz & Leist	220	900
2	4	Rebuilt	Triumph	110	1025

Also many other sizes and types.

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BOILERS

15—150-hp Erie return tubular boilers, 6-ft. x 18-ft. with 70 4-in. x 18-ft. flues. Butt Strap. All complete with stacks.
3—Stirling 500 H.p. Water Tube Boilers. All complete with stacks.

STEAM ENGINES

2—Corliss Horiz. Steam Engines, 36 x 48-in. each. Right- and left-hand.
1—Jeffrey 150 kw.,, 500 r.p.m., 250 v., 545 amp., belt driven. Skinner Automatic, 18 in. x 19 in., self-oiling.
2—Morgan Gardner, 150 kw., 250 v., 600 amp., 350 r.p.m., belt driven by 18-in. x 18-in. Ball Engines.

PUMP

1—Janesville—L.P. Cyl., 12 in.; H.P. Cyl., 26 in.; Stroke 12 in.

AIR COMPRESSORS

1—Mesta Machine Co. Comp. Low Pressure Air Compressor. Bore of Cyl. L.P. Steam, 36 in.; bore of Cyl. H.P. Steam, 22 in.; bore of Cyl. L.P. Air, 34 in.; bore of Cyl. H.P. Air, 26 in.; Stroke, 48 in.; r.p.m., 90; Pressure 100 lb. Corliss Valve Type.
1—Ingersoll-Rand Co. low pressure, Imperial type, No. 10 Cross Compound Air Compressor. Bore of Cyl. L.P. Steam, 34 in.; bore of Cyl. H.P. Steam, 20 in.; bore of Cyl. L.P. Air, 34 in.; bore of Cyl. H.P. Air, 18 in. Stroke 36 in., r.p.m. 100, Pressure 100 lb. Corliss Valve Type.

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2 Boiler Feed Pumps

De Laval Centrifugal Pump, Type 3P3. Total Head 465 ft., 150 G.P.M. Direct connected in single casing with De Laval Turbine, Type 40TC, Steam Pressure 100 lbs. to 175 lbs. Complete with excess pressure and overspeed governors.

Have been in service 2 years.

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Complete power plant, consisting of Two (2) Usel Curtis Turbine General Electric Generator Sets, 600 kw. Unit each, 2300 volts A.C. with Exciters, Transformers, Switch Boards, etc.

3—500 hp. Keeler Water Tube Boilers, complete with Stokers, Soot Blowers, Ash Conveyors, Feed Water Heater, Condensing equipment and spray for cooling.

In excellent condition at an exceptional price.

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Hydraulic Pump

1—22 x 4 x 24 Direct-Acting, Single Plunger Pump, 125 lb. steam pressure, 1500 lb. water pressure, capacity 65 gals. per min., solid forged steel water end. In good condition. Replaced by larger unit.

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Kewanee, Ill.

Barber-Greene Conveyors

1—Style C, 18 in. x 42 ft. belt, motor driven.
1—Style C, 18 in. x 27 ft, belt, motor driven.

Complete specifications upon request. Inspection invited. A-1 condition.

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Generating Units

1—18-in. x 42-in. Corliss Engine, left hand, heavy duty, 85 r.p.m., with flywheels 14 ft. diam. x 27 in. face and 12 ft. diam. x 20 in. face. Mfg. by Bass Foundry & Machine Co.
1—15¼-in. x 18-in. Buckeye Engine, 200 r.p.m., direct connected to a 150-kw. Crocker-Wheeler Generator, 240 v., direct current.

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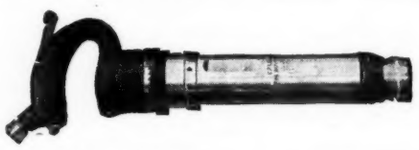

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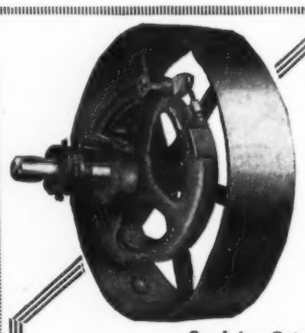

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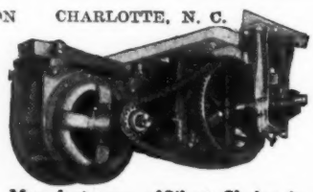

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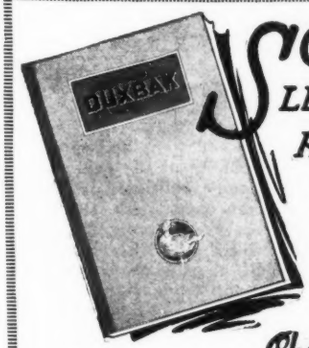

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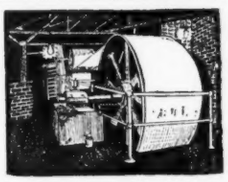

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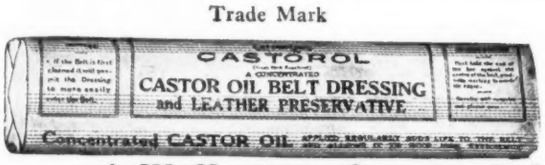

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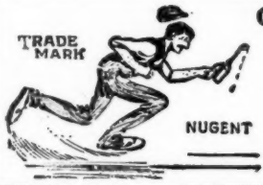

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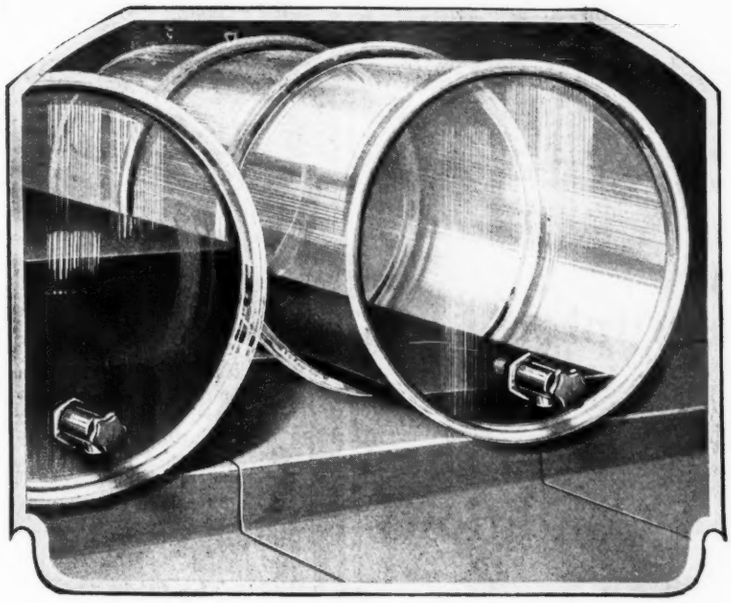

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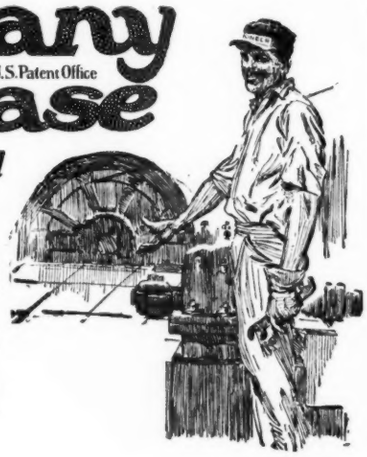

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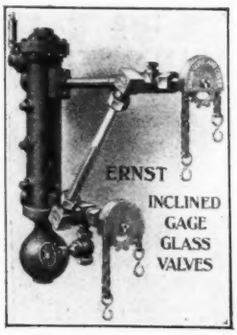

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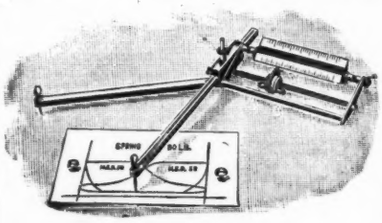

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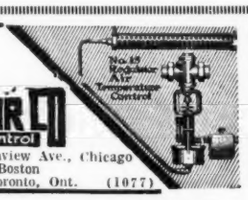

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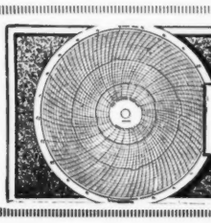

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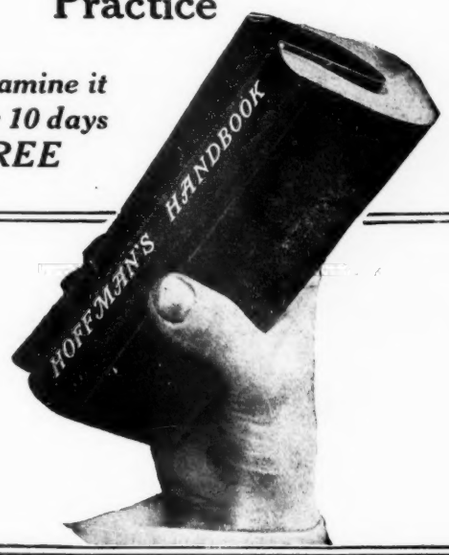

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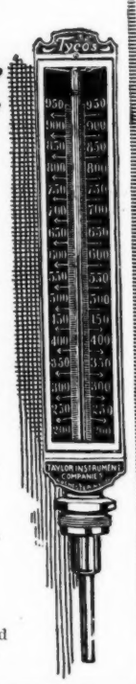

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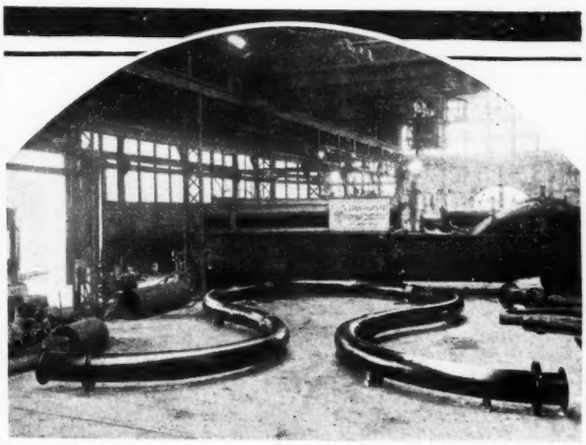

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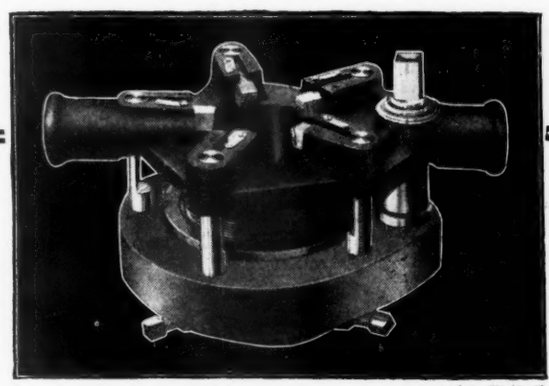
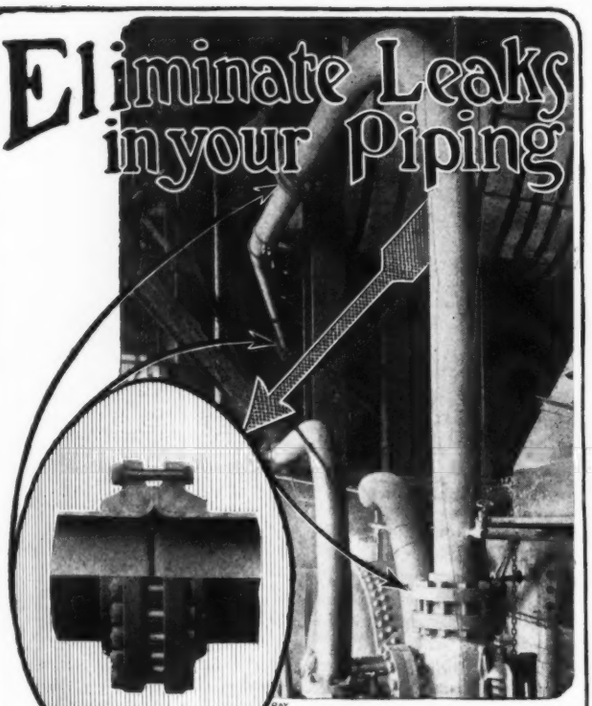


Eliminate Leaks in your Piping



Use Sargol-Weld
(PATENTED)
Joints
in your High Pressure and Super-Heated Steam lines.

THE Sargol-Weld (patented) Joint is gasketless, absolutely leak proof and will last as long as your piping. Specify "Pittsburgh Piping" with Sargol-Weld (patented) Joints for your High Pressure and Superheated lines, the best there is in Power Plant Piping Construction.

Complete Piping Equipment furnished and installed in power plants of all kinds, including Electric Light, Street Railway, Blast Furnace, Steel Works, Paper Mills, Textile Mills and Industrial Plants of any and every description. We are prepared to contract for piping installations at any place in the United States and Canada and for any service, including the highest pressures of superheated steam and hydraulic working pressures up to 5,000 pounds.

PITTSBURGH PIPING & EQUIPMENT CO.

MANUFACTURERS & CONTRACTORS

Specialists in Welded Wrought Steel Headers, Flanged Iron and Steel Fittings, Pipe Bends and Fabricated Piping for Power Plants.

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TRANSMISSION ROPE

"The Rope That's Made to Last"

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Noble and West Streets
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FEATURES

Location of brass seat ring away from pipe contents and all other harmful influences. Prevents the possibility of injury to the seat ring from pipe ends. A patented feature.
Ground ball brass-to-iron joint, ground with mate and never separated.
Sloping shoulder and large play in the ball end, which is of assistance in connecting piping out of line. Standard pipe threads tapered to fit the pipe. Coarse nut threads for quick adjustment.
Heaviest of its class made and sold at reasonable prices. At your jobbers. Write for Catalog.

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Pipe Cutting and Threading Machines

Made for all pipe sizes to 16 inch
Hand belt or motor drive

Write for Catalog Now.

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Steel Exclusively
READING OPEN HEARTH **STEEL**
FLANGES & FITTINGS

Make your entire pipe line of steel, and eliminate breaks due to expansion and contraction.

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ELECTRIC CONTROL UNIT
FOR THE MOTOR OPERATION OF LARGE
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KENNEDY VALVES

have demonstrated their efficiency, reliability and low maintenance cost in power plants throughout the country. 500 different types and sizes. Send for Catalog.

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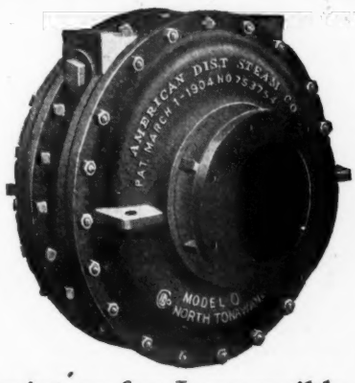

Use Variators for Inaccessible Places

For example, in streets where manholes are prohibitive or objectionable. Adsco Variators are built in single or double types, for taking care of expansion of 50 or 100 ft. of underground steam mains.

Some of these Variators have been underground for thirty years without attention, saving costly repairs and shut-downs.

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GENERAL OFFICES AND WORKS
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Offices:
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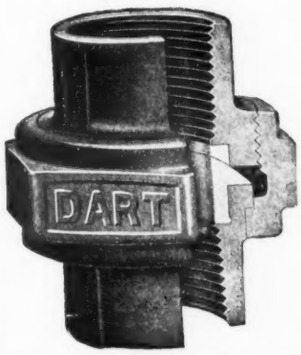
Ask for Bulletin No. 158-W "Adsco Heating" for individual buildings; Bulletin No. 20-W "Community Heating" for groups of buildings.

ADSCO

Prevent Backflow

of steam from the header into a boiler in case of a tube rupture or other break. Equip all boilers with
New Bedford "Whale Brand" Reverse Current Valves
Made of either cast iron or open hearth cast steel with "Nickel Bronze" seats and discs that will not stick. Write.
New Bedford Valve Mfg. Co., New Bedford, Mass.

They Have *Proved Satisfactory*



wherever they have been installed—and that is the principal reason for the wide distribution of

DART UNIONS

Probably it was the **Bronze to Bronze Seats** which prevent corrosion or maybe it was the leakless service which is found in Dart—at any rate they have made good in every respect.

Ask Your Dealer or Write Us Direct.

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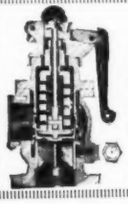
THE WHITE STAR VALVE
The Wm. Powell Co., Cincinnati, O.



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Quality Products for Discriminating Users
with a record of over 50 years of dependable service on high-pressure power plant installations.

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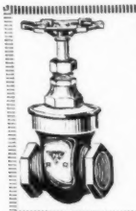

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Brass and Iron Valves for all purposes and pressures
Asbestos Packed Cocks

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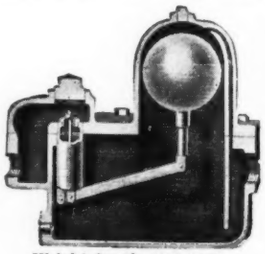
Are Your Profits Stolen By Moisture In Steam?

Wright-Austin Traps Remove All Condensation and Keep Your Steam Working at Topmost Efficiency

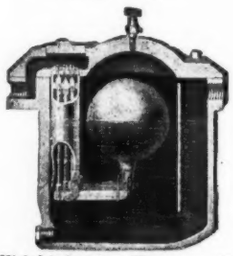
Because the Wright-Austin "Victor" has so much greater capacity than other traps, smaller sizes or by grouping the drains, a smaller number of "Victor" Traps may be used with decided economy in first cost as well as in maintenance—thereby reducing your steam trap costs.

The "Victor" Trap is especially adapted for continuously draining large volumes of condensation from low pressure apparatus, such as heating systems, dryers, coils, evaporations, etc.

Extreme simplicity, great capacity and low cost are dominant features of the "Victor" Trap.



Wright-Austin "Victor" Steam Trap



Wright-Austin "Emergency" Steam Trap

Wright-Austin "Emergency" High Pressure Trap has been called the "Three-in-one" Trap, because it really does the work of three ordinary traps and reduces steam trap costs accordingly.

With its three valves—an exclusive feature that enables this trap to handle small quantities as well as floods of condensation—the "Emergency" has tremendous capacity.

Buy your steam traps on a capacity basis — not pipe size — insist on "Emergency," and you will cut your expense for traps to the lowest possible minimum.

(71)

WRIGHT AUSTIN

WRIGHT-AUSTIN COMPANY

Standard with STEAM USERS SINCE '94

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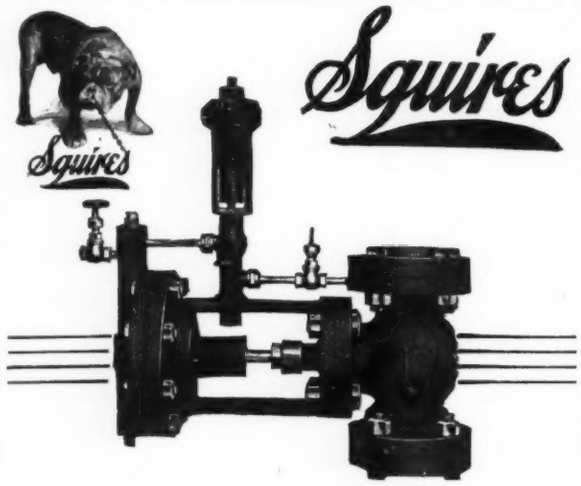

Class "E" Pump Governor

Insist on the Genuine
It Does the Work!

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THE C. E. SQUIRES COMPANY

East 40th Street and Kelley Ave., Cleveland, Ohio

Piston Type

CONSTANT Excess Pressure On the Feed Line is BEST

It is absolutely necessary for highest possible operating efficiency and economy. Have you had any difficulty in maintaining a FIXED excess pressure on your feed lines?

This trouble can be completely overcome by equipping your feed pumps with

FULTON Boiler Feed Pump GOVERNORS

They automatically maintain a CONSTANT difference between the pressure in the feed pipe and the pressure in the boilers. No matter how the steam pressure varies, this excess will always remain constant. The speed of the pump is automatically regulated according to the requirements of the boiler. When little water is needed, the governor cuts down the pump speed by throttling its steam supply, and vice versa.

Absolutely reliable in operation. Made in two types—piston and diaphragm.

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The Chaplin-Fulton Mfg. Co.

28-34 Penn Avenue, Pittsburgh, Penna.

Also Manufacturers of the Vigilant Feed Water Regulator

Easy to Take Apart

Did you ever take a radiator trap apart and then try to put it together again? Some job, wasn't it? All makers of radiator traps don't stop to consider that a trap *will* collect scale and dirt—and that it *must* be cleaned. Some do not even seem to realize that it is desirable to remove the elements in new installations, while operating as a gravity system until all scale and dirt are washed out.

It's a simple matter to simply lift the elements out of a

Radiator Trap

SARCO

Removing the elements does not affect the adjustment of a Sarco because they are not attached to body or cap.

The simple act of unscrewing removes the cap, which allows the elements, including the strainer, to be removed bodily. After cleaning, the elements are quickly slipped back into place.

The "Sarco," incidentally, is particularly free from those troubles ordinarily caused by dirt and scale. The *line* contact between the cone-head valve and circular seat prevents scale from collecting, as with flat surface seats. Moreover, the valve mechanism is protected against scale and dirt by a screen having a mesh ten times the area of the valve seat.

Many other points of superiority are clearly described in our interesting Booklet A-108. Write for a copy today.

SARCO CO., INC.

229 Broadway, New York City

Buffalo Chicago Cleveland Detroit Philadelphia

Here's why we say:

"It's different!"

THE Armstrong principle is *new* in that it's different—but it is *not* an experiment. Years of use have proved every Armstrong feature:

Greater Capacity—than any trap of equal size. Powerful leverage insures full opening of valves.

Self-Scrubbing—Discharge is at the top so accumulation of oil sediment, etc., is washed out by high velocity discharge.

Cannot Pass Steam—Closure is positive; velocity high when discharging.

Action Quick and Positive—both in closing and opening valve due to quick passing of point of balance of the bucket.

Non Air-Binding—port permits positive discharge of air and incondensable gases.

Small Size—easily supported by any line.

Low Cost—without sacrificing high quality, because of simplicity.

Armstrong Machine Works

312 Maple Street

Three Rivers, Mich.

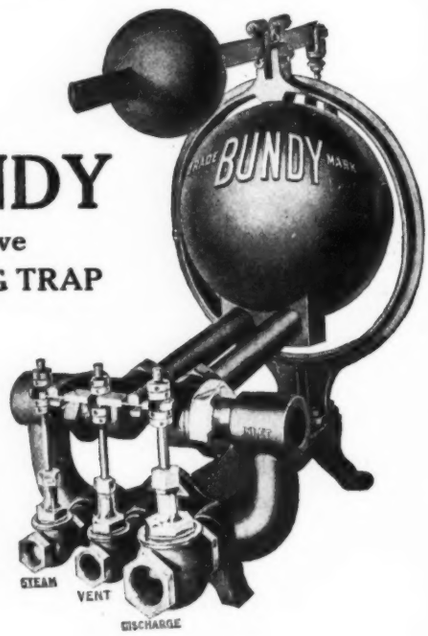
Armstrong Steam Trap

The New

BUNDY

Three Valve

PUMPING TRAP



Extra large in capacity. Handles very large quantities of condensate under low pressure or vacuum and pumps it automatically to any elevation to which the available live steam can lift it.

Get all the facts. Write for Bulletin "P"

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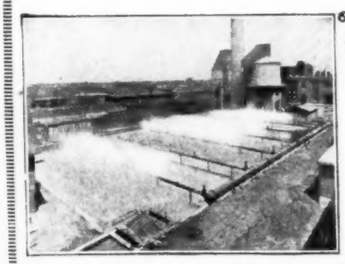
Nashua, N. H.

W. W. Booth, 26 Cortlandt St., New York City



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COOLING PONDS

Have demonstrated in over 500 complete installations their superior cooling capacity and preference to cooling towers.

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WATER
Softeners & Filters

Iron and Oil Removal Apparatus–Filtration Equipment–Water Conditioning Apparatus of every description

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Good judgement in buying

THE JOHN H. McGOWAN CO.
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STERLING
Steam Traps

They return condensate *nearly as hot as steam* direct to the boilers. *Write* for descriptive matter.

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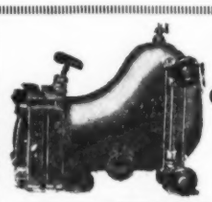
115 Business St., Hyde Park, Mass.

"HAZLETON" PRIMING PUMPS

equipped with a vacuum breaker installed about 2 ft. above the centrifugal pump; prevents water entering priming pump; handles air; consumes little power.

BARRETT, HAENTJENS & CO., HAZLETON, PENNA.



McDaniel Improved Traps
mean
CONTINUOUS OPERATION
without Steam Leakage
Write for information

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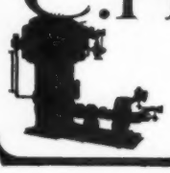
C.H.WHEELER CONDENSING EQUIPMENT



Surface Condensers, Low Level Jet Condensers, Barometric Condensers, with all auxiliaries, including the Radojet Ejector Air Pump

C. H. Wheeler Mfg. Co., Philadelphia, Pa.

Type CCC Coppus Centrifugal Turbo Boiler Feed Pump single stage. Appropriate for all plants operating at moderate boiler pressures. Furnished in compact single units that are easily installed.

Eliminate Damaging Pulsations In Your Boiler Feed

By taking the shock out of feed water flow you banish practically all troubles and reduce repair costs to a minimum. Coppus Turbo Boiler Feed Pumps provide a steady flow of water without pulsations. This insures longer life and less repairs to pipe lines, valves, fittings, etc. Much less attention is required than with reciprocating pumps. Oiling is necessary only a few times a year. A substantial saving in labor results.

Many other advantages are enumerated in our Bulletin.

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Coppus Engineering Corporation
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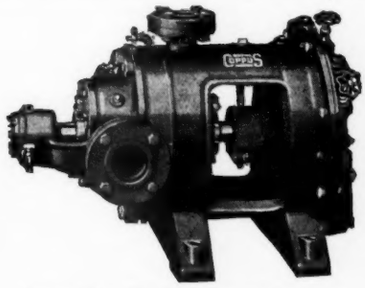

Coppus Type TB Turbo Boiler Feed Pump, two-stage for pressures up to 300 pounds. Contains only two stuffing boxes—both under suction pressure. Specially designed and built of the finest materials for boiler feeding. Carefully balanced. Single unit construction that avoids danger of distortion, eliminates flexible coupling and occupies minimum space.

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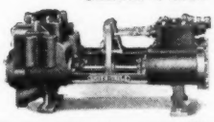
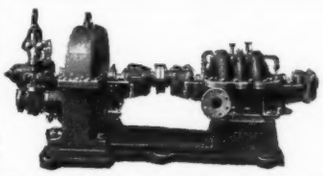
Smith-Vaile PLATT Pumps



Steam and Power Pumping Machinery



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Alberger Pump & Condenser Co.
140 Cedar St., New York City
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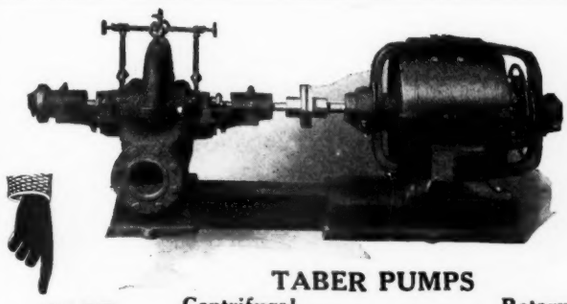

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A six-inch vest pocket scale. Just ask for it when you write.

Centrifugal Rotary
The result of over 40 years' experience in building the highest quality pumps. Unexcelled in every detail. Maximum efficiency with the required operating characteristics for the specified service. Write for Bulletins now.

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D'Olier Centrifugal Pumps

HIGH GRADE
HIGH EFFICIENCY

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FOR DRY STEAM

Guaranteed 99.5% dry regardless of length of the steam line with

WYOMING AUTOMATIC ELIMINATORS

They combine a high quality separator with a trap in a single piece of equipment

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LEA-COURTENAY PUMPS

Centrifugal pumping machinery for every kind of pumping service.

Lea-Courtenay Co.
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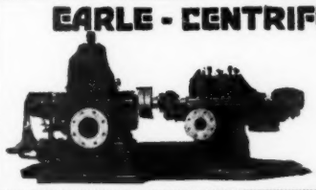

For all purposes where centrifugal pumps of the better class are adapted.

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CENTRIFUGAL PUMPS
HYDRAULIC DREDGES
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Standard Equipment
for more than 40 years

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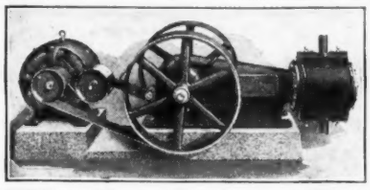

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They represent the best practice in their respective class. PENNSYLVANIA Plate Valves on compressors an outstanding feature. Very high efficiency. Quiet, smooth operation. We also build a complete line of centrifugal pumps. Write for Bulletins.

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Power Transmitting Machinery

We make a complete line of Power Transmitting Machinery, Shafting, Rope Transmission, Machine Moulded and Cut Iron and Steel Gears for heavy service.

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ENGINEERS—FOUNDERS—MACHINISTS
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"INDUSTRIAL" CRANE
Cuts Force 75%

Users of "INDUSTRIAL" Locomotive Cranes report:
"Three men and our Type E, 15-ton 'INDUSTRIAL' now do the work which formerly required twelve men."
"Our 'INDUSTRIAL' paid for itself during the first year's operation—saving $15.66 per car loaded over hand labor."

Take a look around your plant and consider whether an "INDUSTRIAL" could save money for you as it has for the above people.
Names will be furnished upon request.
INDUSTRIAL WORKS, BAY CITY, MICHIGAN

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AND
AERIAL WIRE ROPE TRAMWAYS
Send for Illustrated Catalogue
American Steel & Wire Company
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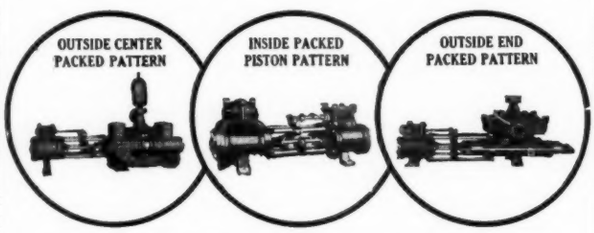
DURABLE DUPLEX STEAM PUMPS



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Pumps---Governors---Compressors
Into every Gardner workman is instilled the rigid ideas of quality which have been a distinguishing mark of Gardner products for more than 60 years.
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Men who live with machinery day in and day out appreciate the smooth and trouble free service marked by the Warren Standard.

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Main Office and Works
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are used in all parts of the country. Write for catalog S. which shows how and where some of these installations are used.

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PUMPS
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THOUSANDS IN USE
FOR STORING AND RECLAIMING, LOADING AND UNLOADING CARS, TRUCKS AND WAGONS
DOES THE WORK OF FROM 6 TO 12 MEN
AND KEEPS EQUIPMENT MOVING
WRITE FOR LITERATURE
PORTABLE MACHINERY CO., PASSAIC N.J.

You Should Worry

The day of begging someone to swing the shovel is past. It's an unsatisfactory method of handling your coal anyway. Not only is it costly, but a source of constant annoyance and worry.

Why not equip your power plant with modern facilities for handling this work easily, efficiently and economically?

A **Godfrey Conveyor** will completely solve your problem. It is the most highly satisfactory method of unloading coal and similar materials from cars to bins, boiler room and storage — a system that will cost you no more than the price of a good truck.

It is adaptable to the requirements of every industrial firm, both large and small.

An inexpensive installation of **Godfrey Equipment** will relieve you of all worry over labor difficulties, it will eliminate demurrage charges, and it will save you money from the start.

Complete information regarding the **Godfrey System** will be mailed upon request.

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The Godfrey Conveyor Company

Elkhart, Indiana, U. S. A.

BUILT STRONGER LASTS LONGER

G-W COAL HANDLING EQUIPMENT

One Conveyor —or a Gang?

Which do you use for your coal handling? One means economy—the other, wasteful expense.

One G-W Portable Belt Conveyor often replaces 3 or 4 men on one coal handling job. It handles coal speedily—in fact the conveyor with 12 inch belt width has a maximum capacity of 73 tons of coal per hour; the 16 inch, 100 tons of coal per hour.

If you must unload coal from car or barge, transfer it from pile to pile, or to truck, bin or hopper, you will be interested to know how others have used a G-W Portable Belt Conveyor for this work with a considerable saving in time, labor, and money. Just address the nearest G-W Office for complete information.

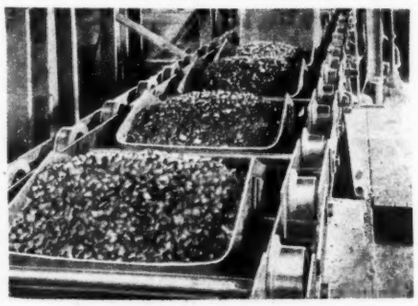
Main Office & Works: Hudson, N. Y.

New York: 50 Church St. Boston: 24 Milk St.
Chicago: 565 W. Washington St. Buffalo: Electric Bldg.

2136-R

Gifford-Wood Co.

HUNT NOISELESS PIVOTED BUCKET CONVEYORS



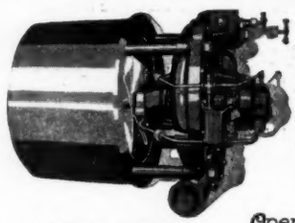
It will reduce coal handling costs, by requiring less power and fewer repairs. Buckets cannot be overloaded and cannot spill. All buckets are interchangeable. Slack is easily taken up.

Consult us on all coal and ash handling problems.

Write for Bulletins

C. W. HUNT CO., INC.
West New Brighton, N. Y., U. S. A.

For Every Stoker and Hand Fired Furnace



Wing Turbine Blower

The Original 1905 — The Standard since 1905

Eliminates Ducts
Simplifies Installation
Low in first, Operating, and maintenance Costs

L. J. Wing Mfg. Co.
9th Ave. & 13th St
New York

Send for Bulletin 57 S.

Webster Equipment

Elevating, Conveying and Coal Rehandling Machinery

Put your problems up to the engineers of a company which has ranked high for over forty years.

The Webster M'f'g Company
Factories in Chicago and in Tiffin, Ohio
Executive Offices: 4500 Cortland St., Chicago
Sales Offices in Principal Cities

Power Simplex
Turbo-Blowers
For Your Boiler Draft
Turbines-Damper Regulators
Ask for Catalogue "21"
Power Turbo-Blower Co.
350 Madison Ave., New York

MECHANICAL DRAFT FANS
and High Speed Vertical Steam Engines

Let us refer you to a Clarage installation in your vicinity

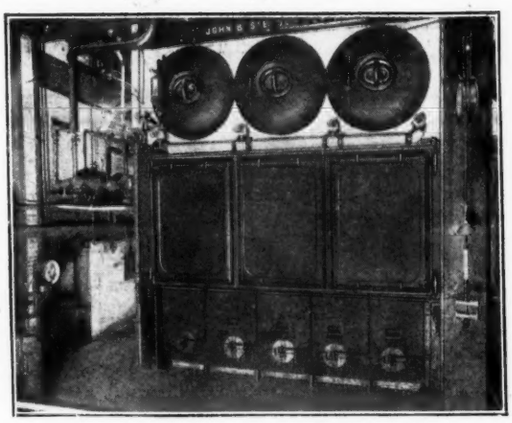
CLARAGE FAN CO., Kalamazoo, Mich.
Mfrs. of Fans, Blowers, Heaters, Engines, etc.

Fuller-Lehigh System PULVERIZED COAL

Insures the maximum fuel burning economy, longer life to furnace and reduced labor cost. *Bulletin 600-E.*

Fuller-Lehigh Co.
Fullerton, Pa.

KOERTING
OIL BURNING EQUIPMENT



Koerting Oil Burning Equipment under boilers at John B. Stetson Co. plant, Philadelphia, Pa.

A complete system that preheats, strains, pumps and burns the fuel oil smokelessly at the highest efficiency. The equipment is in duplicate, assembled in a compact and perfectly accessible unit, insuring the maximum reliability. Adapted to all boilers. Consultation invited.

Address Oil Firing Department

SCHUTTE KOERTING
1150 THOMPSON STR
PHILADELPHIA·PA

No Clogged Tips

Aside from the much higher efficiency obtained—the renewable non-clogging adjustable tip mounted on the burners of the

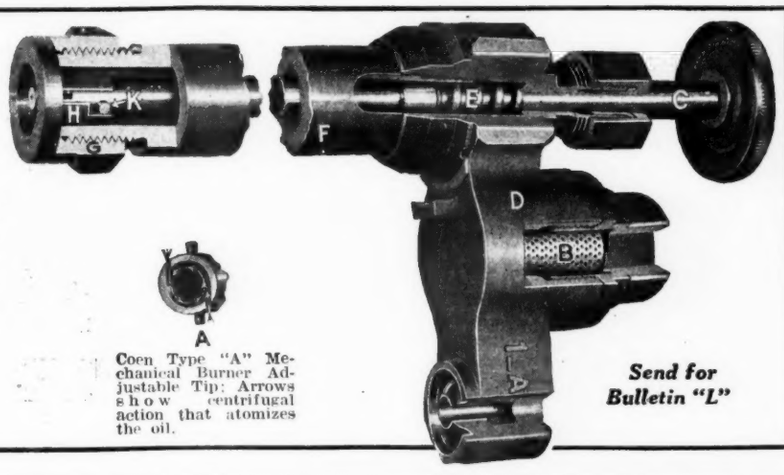
COEN
System of Low Pressure Mechanical Oil Burning Apparatus

has a decided advantage. No danger of carbonizing. Centrifugal force is the agent used to effect the complete atomization of the oil. A steel rod running through the burner is the means for regulating the discharge from the tip.

Operate with any gravity fuel oil. Unexcelled in flexibility—always under full control of fireman. Adapted to either natural or forced draft or a combination of both.

The complete system is exceptionally compact and accessible for inspection. All apparatus is in duplicate units. Write for full particulars.

COEN COMPANY, INC.
112 Market St., San Francisco
50 Church St., New York
Agents in principal cities



Coen Type "A" Mechanical Burner Adjustable Tip; Arrows show centrifugal action that atomizes the oil.

Send for Bulletin "L"

Turner Baffle Walls
Produced exclusively by The Engineer Company

The Engineer Co.
17 Battery Place
New York City

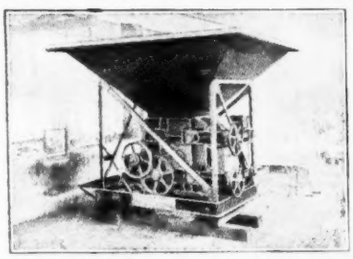
Sales Offices in the Larger Cities

Balanced Draft
Produced exclusively by The Engineer Company

Bethlehem (Dahl)
Mechanical Oil Burning System

BETHLEHEM SHIPBUILDING CORPORATION, Ltd.
BETHLEHEM, PA.
General Sales Offices: **25 BROADWAY, NEW YORK CITY**

O. S. DEPENDABLE



Multiple roll slow speed coal crusher guarantees uniform size of coal for stoker purposes.

Bronze bushed power shaft bearings equipped with positive feed lubricators assuring continuous operation with low maintenance cost.

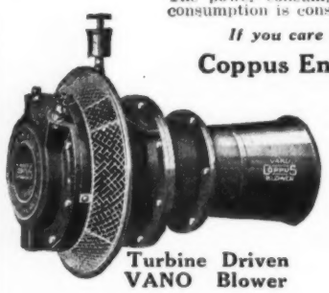
ORTON & STEINBRENNER CO.
***Factory*—Huntington, Ind.**
***General Office*—608 S. Dearborn St., Chicago, Ill.**

More Efficiency With Less Power

The efficiency, for instance, of Coppus VANO Blowers is around 80 per cent for both high and low pressures. The power consumption, size for size, is less than that of any other type. At constant speed, the power consumption is constant, whatever may be the pressure changes or the amount of air delivered.

If you care anything about economy you will eventually use them. See list of uses below.

Coppus Engineering Corporation, 350 Park Ave., Worcester, Mass.



Turbine Driven VANO Blower

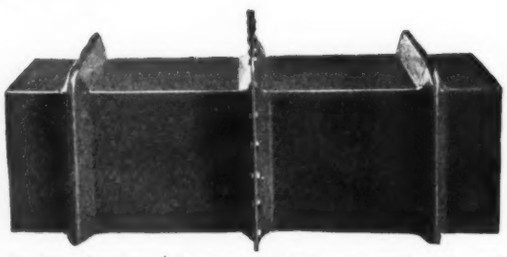
USES
Undergrate draft
Induced draft

COPPUS VANO BLOWER — IT'S ALL IN THE VANES

USES
Heating
Cooling
Drying
Ventilating
etc.

Electric Driven VANO Blower

Two of a kind for Efficiency



Section showing enlargement of V-shaped projection and connecting joint. Note corner and welded construction.

CONNERY'S
Indestructible Smoke Flues

"Cost No More Than Other Types"

Made with V-shaped projections stamped into the plates. These serve a double purpose—first to provide free expansion and contraction and second to provide extra strong stiffening without the use of angle irons. All joints are electrically welded and positively leakless under forced or induced draft.

Let us solve your smoke flue problem. Write for full details.

Connery and Company, Inc., Second and Pike Sts., Philadelphia, Pa.

MANUFACTURERS

G. B. Nicholson & Co., New York Selling Agents, Grand Central Terminal

PLIBRICO is sold only in containers of distinctive appearance as shown below.

Here's *your* furnace lining—

PLIBRICO
JOINTLESS
FURNACE LINING

A PLASTIC refractory in unbaked form that conforms to all furnace shapes and can be installed by anyone who can use a mallet. This steel container keeps it in perfect condition and identifies the only "Jointless Fire Brick"—the one-piece refractory lining that outlasts ordinary fire brick from 2 to 4 times and resists temperature to 3100 deg. F. The way to better furnace linings is the subject of the new booklet. Where shall we send it?

Warehouse stocks in principal cities.

JOINTLESS FIRE BRICK CO.
3111 CLAY ST. CHICAGO, ILL.

Ask for this booklet

GREEN'S
HI-EFFICIENCY HI-SPEED
RADIAL FLOW FANS

Let them supply your forced draft at a large saving in operating and upkeep cost.

Built in sizes to handle from 1600 to 275,000 cu.ft. per minute at pressure up to 7 inches of water.

Learn why they are more efficient. Write for Bulletin No. 152.

THE GREEN FUEL ECONOMIZER CO.
BEACON, N.Y.

LIPTAK

Liptak Double Suspension Arch Liptak Single Suspension Arch
Liptak Furnace Wall Support

If you are interested in reducing upkeep costs let us advise with you.

Write for detailed information

Liptak Fire-Brick Arch Company
120-122 So. Ninth St., Minneapolis, Minn.
Offices in Principal Cities

Ballard, Sprague & Company Inc.
Boiler Settings Chimneys
200 5th Avenue New York

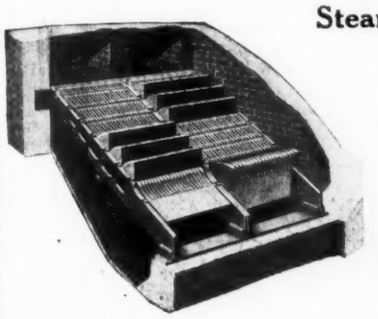
AJAX
Rocking Grates

Repeat orders from leading American and foreign power plants prove that Ajax Grates are efficient and economical.

Low cost for maintenance alone would justify your selecting Ajax in preference to all other shaking grates. Investigate.

Valley Iron Works
Williamsport, Pa.

Increased Steam Production



Don't buy new boilers—until you are certain that it is necessary.

The installation of PERFECTION HAND STOKERS will increase the steaming capacity of your present boilers, and at the same time will permit cheaper coals to be burned.

They save money to their owners and much back breaking labor to the firemen.

Write for Bulletin.

PERFECTION GRATE & SUPPLY CO.
Springfield, Mass.

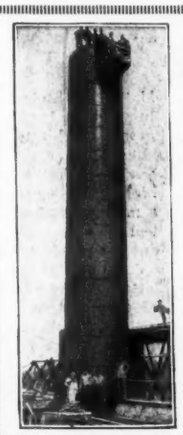
The Mercury U-Tube Principle

as applied to automatic boiler regulation in the

CARRICK COMBUSTION CONTROL

results in permanent gradual operation to maintain the correct ratio of air to fuel in accordance with the steam demand.

CARRICK ENGINEERING CO.
1094 Rand McNally Bldg., CHICAGO



STEEL STACKS
··BREECHINGS··
TANKS OF ALL KINDS
FABRICATORS AND ERECTORS OF SPECIAL PLATE STEEL WORK

SEND US YOUR SPECIFICATIONS OR BLUE PRINTS FOR QUOTATIONS

LITTLEFORD BROS.
410 E. PEARL ST.
CINCINNATI — OHIO

DAILY CAPACITY 150,000

A.P. Green Fire Brick

MEXICO, MISSOURI

SIL-O-CEL

TRADE MARK REGISTERED U.S. PATENT OFFICE

MADE FROM CELITE

Insulating Brick and Powder

Saves 60 per cent to 70 per cent of the heat lost through boiler walls and settings. Write for Bulletin K-6A.

CELITE PRODUCTS COMPANY
New York, Philadelphia, Cleveland, Detroit, Chicago, St. Louis, New Orleans, Denver, Los Angeles, San Francisco.

AMERICAN CHIMNEY CORPORATION
OF NEW YORK

Radial Brick Chimneys
Chimney Repairs

MAY WE SEND YOU OUR CATALOGUE?

Main Office: 147 Fourth Avenue, New York
BRANCHES: Chicago, Cleveland, Philadelphia, Boston.

Green

Chain Grate Stokers — **Steam Jet Ash Conveyors**
Cast-Iron Hoppers — **Pressure Waterbacks**
Sealflex Arches — **Fuel Retarders** — **Coal Bunkers**

Write to Dept. A for Literature

Green Engineering Co., Dept. "A"-40, Kennedy Ave., E. Chicago, Ind.

Radial Brick Chimneys

Alphons Custodis Chimney Construction Co.

Also Experts in
Repairing Brick and Concrete Chimneys
Heightening Chimneys
Lightning Rods Installed and Repaired
Work done while chimney is in operation, if necessary.

95 Nassau Street, New York City

CYCLONE GRATES

make *all* of your fuel count in power. *Write for full details.*

CYCLONE GRATE BAR CO.
Buffalo, New York

BETSON'S PLASTIC FIRE BRICK

for permanent one-piece boiler furnace linings and baffles. No bricks to fall out. Ready (in yellow-top barrels) for any one to do the job, from warehouses in principal cities. Saves waiting for repairs.

THERE IS ONLY ONE "PLASTIC FIRE BRICK"

SEND FOR CATALOGUE

BETSON PLASTIC FIRE BRICK CO. INC. ROME, N.Y.

High Grade Fire Clay Brick for Boiler Settings

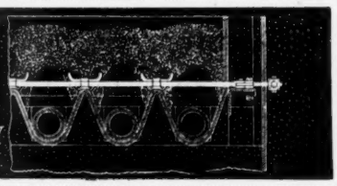
Plants in Pennsylvania Ohio Indiana, Kentucky and Alabama

Harbison-Walker Refractories Co., Pittsburgh, Pa.

THE NEGUS-TIFFANY COAL AGITATOR

WET COAL DIFFICULTIES DEFINITELY CURED

W.E. ELLIS COMPANY
HAVERHILL, MASS. U.S.A.



"MONO" TRADE MARK REG. U. S. PAT. OFF. BOILER BAFFLES ARE MONOLITHIC

AND "HUG THE TUBES" AT ANY ANGLE

AND ARE NOT DAMAGED WHEN TUBES ARE WITHDRAWN, REPLACED OR BY THE USE OF A TURBINE CLEANER.

OUR ENGINEERS ARE AT YOUR SERVICE TO HELP YOU SOLVE YOUR COMBUSTION PROBLEMS. THE CUT ON THE RIGHT IS AN EXAMPLE OF WHAT WE CAN DO FOR YOU.

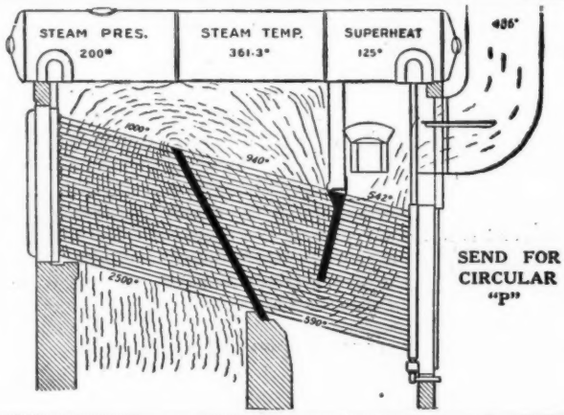
KING REFRACTORIES CO.

MAIN OFFICE-WORKS BUFFALO, N. Y.

Engineering Department, 705 Greenwich St., New York

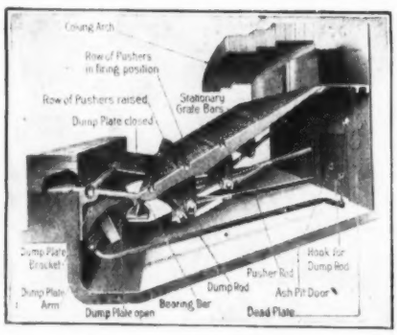
Boston, Philadelphia, Pittsburgh, Detroit, Cleveland, Cincinnati, Toledo, Columbus, Chicago

Toronto, Canada, Grant E. Cole Co.



SEND FOR CIRCULAR "P"

Specify NATIONAL Stokers



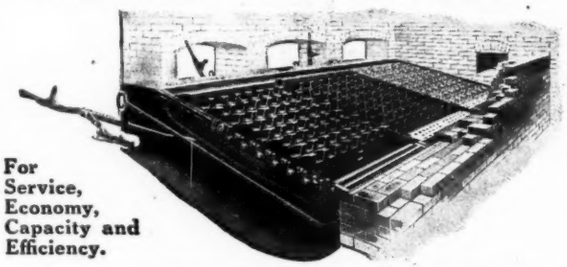
National Stokers burn the lowest grade of bituminous coals smokelessly—giving the high efficiency of a modern mechanical stoker, without the power and upkeep cost of the latter. Burns cheapest fuels without smoke or waste. Write for full details.

The M.A. Hofft Co. Indianapolis, Ind.

When You Buy a Hand Stoker, Buy a GOOD One

COKAL HAND STOKERS

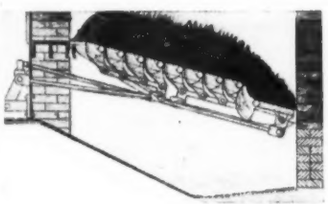
THE SIMPLEST STOKER IN THE WORLD



For Service, Economy, Capacity and Efficiency.

COKAL STOKER CORP. 343 E. OHIO ST., CHICAGO

Files Hand Stoker



A large dyeing plant equipt one 300 hp. boiler. They have since ordered six additional stokers.

Gibby Engineering Company

East Boston, Mass.

Marion Hand Fired Stokers

Non-interlocking teeth of special design present very small openings which will not permit the loss of live coals or unburned fuel. Nothing but fine ash can drop through into the ash pit.

Movement of the fuel bed is positive and continuous from step to step over the grate toward the dumping plate. Every bit of energy from the coal is extracted by this economical clean method of firing.

Marion Machine Foundry & Supply Co.

Marion, Indiana

MARION POWER PLANT EQUIPMENT

Legs shown in cut are optional

The standard for over 20 years.

To Save Fuel—

Higher combustion economy is obtained by the better design of

NEEMES GRATES

Correct in principle. Unexcelled in quality. Ideal for low grade bituminous fuels. Write us for Catalog, now.

Established 1874

NEEMES BROTHERS, Inc.

41-49 Adams Street, Troy, N. Y.

Representatives in

New York, Montreal, Philadelphia, Providence, Chicago, Columbus, Baltimore, St. Louis

HUBER HAND STOKER

Sole Manufacturers

FLYNN & EMRICH COMPANY, Baltimore, Maryland

ILLINOIS CHAIN GRATE STOKERS With Dampered AIR CONTROL

Forced or Natural Draft

ILLINOIS STOKER CO. 104 W. 7th St., Alton, Ill.

Chgo.: Ernest E. Lee Co., 115 S. Dearborn St.; Kans. City; J. F. Pritchard & Co., Reliance Bldg.; New York: H. G. Meissner, 141 Broadway; Minneapolis: H. R. N. Johnson, 917A Marquette Ave.; Indianapolis: R. H. Bennett, 305 Merchants Bank Bldg.

Detroit V-Type Stokers for the Public Schools

Cass Technical High School, Detroit, equipped with Detroit V-Type Stokers

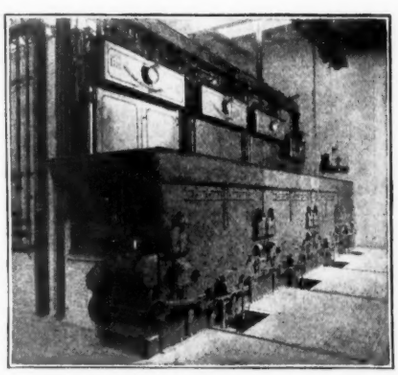
The popularity of Detroit V-Type Stokers in the public schools bears witness to their value from an investment standpoint, for all natural draft furnaces —whether under fire tube or water tube boilers.

Detroit V-Type Stokers are money-makers in schools, public buildings, industrial plants—and wherever used. With them: (a) average overall efficiencies of 70-75 per cent may be maintained, (b) operator can fill coal hoppers and then attend to other duties, (c) cheaper grades of fuel can be burned than with hand firing.

Hundreds of schools have been equipped. Here are just a few:

Ashtabula High School, Ashtabula, Ohio
Baldwin School, Pontiac, Michigan
Cass Technical High School, Detroit, Michigan
Cleveland Heights High School, Cleveland, Ohio
Crosby High School, Waterbury, Conn.
Dewey School, Flint, Michigan
Colored High School No. 174, Washington, D. C.
East Boulevard School, Cleveland, Ohio
East Dennison School, Cleveland, Ohio
East High School, Cleveland, Ohio
East Technical High School, Cleveland, Ohio
Eastern High School No. 176, Washington, D. C.
Benjamin Franklin Jr. High School, New Castle, Pa.
Hoffman School, Cincinnati, Ohio
Indiana School for the Blind, Indianapolis, Indiana
Indianapolis School No. 32, Indianapolis, Indiana
Indianapolis School No. 51, Indianapolis, Indiana
Jefferson Jr. High School, Rochester, New York
Kennard School, Cleveland, Ohio
Lincoln High School, Cleveland, Ohio
Madison Jr. High School, Rochester, New York
Sidney T. Miller Jr. High School, Detroit, Michigan
Monroe Jr. High School, Rochester, New York
Northeastern High School, Detroit, Michigan
Northern High School, Detroit, Michigan
Northwestern High School, Detroit, Michigan
Rochester School No. 8, Rochester, New York
School for the Deaf, Cleveland, Ohio
Selberling School, Akron, Ohio
Shaw High & Technical Schools, East Cleveland, Ohio
Southeastern High School, Detroit, Michigan
Washington Park School, Cleveland, Ohio
Webster School, Pontiac, Michigan
West High School, Cleveland, Ohio
West Oakley School, Cincinnati
West Technical High School, Cleveland, Ohio
Wilby High School, Waterbury, Conn.
Wilkinsburg Public School, Wilkinsburg, Pa.
Willard School, Cleveland, Ohio
Winona High School, Winona, Minnesota

On every score your boilers should be equipped with Detroit Stokers. Remember, there is a type for every purpose—V-Type Overfeed for natural draft—Single Retort Underfeed for forced draft with boilers developing up to 300-400 H. P.—Multiple Retort Underfeed for large boilers.



Ask for Bulletin 324

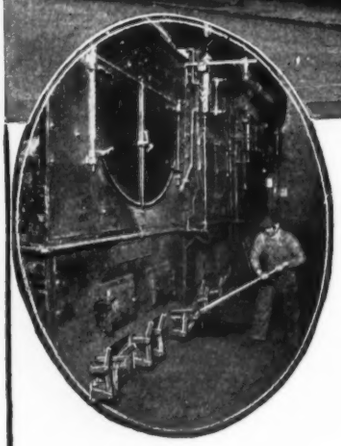
DETROIT STOKER COMPANY

Underfeed Forced Draft and Overfeed Natural Draft Stokers

324 GENERAL MOTORS BLDG. DETROIT, MICHIGAN

DETROIT UNDERFEED STOKERS

BUILT FOR BIG BUSINESS



Performance versus Promise

2 boilers do work of 3

Performance not promise is what the VOGT BROTHERS HAND STOKER gives, as evidenced by the fact that two VOGT BROTHERS stokers are doing the work formerly done by three mechanical stokers in the plant of the U. S. Foil Co., Louisville, pictured above.

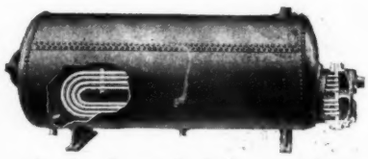
What the VOGT BROTHERS HAND STOKER is doing for this, the largest plant of its kind in the world, it will do for you in increased boiler efficiency and great fuel economy.

Our combustion engineers are ready to help solve your power problems.

VOGT BROTHERS MFG. CO.
LOUISVILLE, since 1891. KENTUCKY

VOGT BROTHERS
THE POPULAR VOGT
HAND STOKER

HOT Water for all domestic and industrial purposes *guaranteed* by



The Patterson System

Patterson-Kelley Co.
100 Park Ave., New York

Hot Water supplied at minimum fuel cost.

The BLACKBURN-SMITH FEED WATER FILTER and GREASE EXTRACTOR

removes oil, grease and dirt from boiler feed water made up of condensed exhaust steam and dirty raw water.

Reduces coal and water bills.

Ask for our free Booklet.

The BLACKBURN-SMITH CORPORATION
107 Park Ave., New York

MODEL AUTOMATIC SMOKELESS FURNACE

Burns the cheapest coal at high efficiency.

Model—Chicago Chain Grate Model—Acme Engine

THE AUTOMATIC FURNACE COMPANY
Dayton, Ohio

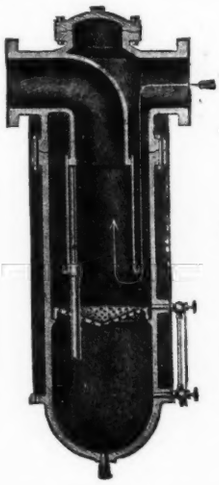
STANDARD

Multicoil Evaporators
Multicoil Feed Water Heaters

Standard Water Systems Co. of New Jersey
Hampton, New Jersey

WE-FU-GO AND SCAIFE
WATER PURIFICATION SYSTEMS SOFTENING & FILTRATION FOR BOILER FEED AND ALL INDUSTRIAL USES
WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

M. H. DETRICK CO.
155 East Superior Street, Chicago, Ill.
Will Mail Catalogs to Those Interested In—
DETRICK FLAT SUSPENDED ARCHES
DETRICK STEAM JET ASH HAGAN CONVEYOR



Not the Cheapest — in price— BUT "The Cheapest to Buy"

In assured delivery of dry steam at all times and the resulting operating economy of your turbines, engines, pumps and compressors.

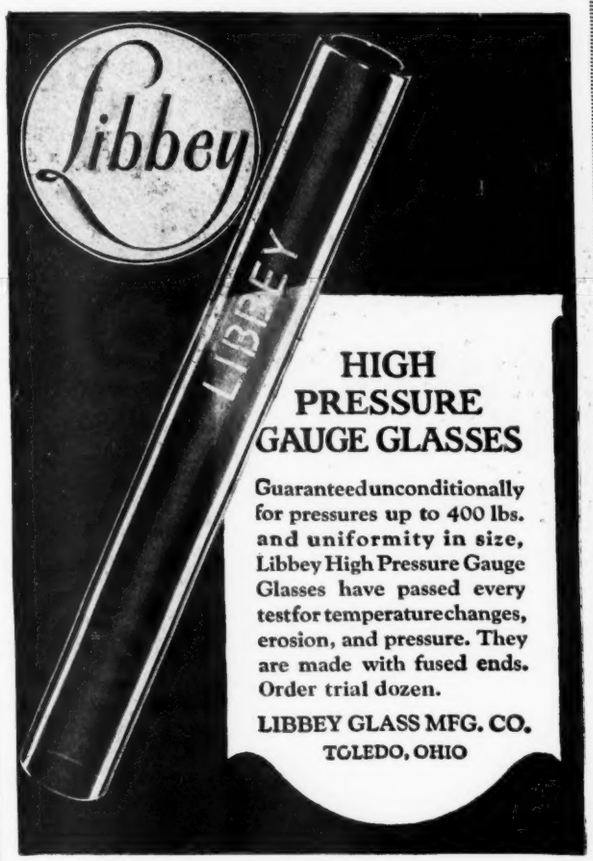
Sweet Direct Separators

will net you a bigger return per dollar invested than separators that you can buy for a much lower price. In design, high-grade materials and workmanship the Sweet is unexcelled.

The moisture is separated by capillary attraction, and the sudden reversal of the steam current. The design is right—and has proved its high efficiency by years of continuous hard service.

Write us for full details

Direct Separator Company
710 Geddes Street, Syracuse, N. Y.



HIGH PRESSURE GAUGE GLASSES

Guaranteed unconditionally for pressures up to 400 lbs. and uniformity in size, Libbey High Pressure Gauge Glasses have passed every test for temperature changes, erosion, and pressure. They are made with fused ends. Order trial dozen.

LIBBEY GLASS MFG. CO.
TOLEDO, OHIO

The Toughest Gauge Glasses Come from SCOTLAND

Scotch sand makes the finest glass in the world, and "Moncrieff" Gauge Glasses are made of it. "Moncrieff" is the ONLY genuine Scotch gauge glass. That's one reason they last longer than others and are tougher and clearer. The other reason is found in the manufacturing process.

And the PROOF of this better service will be found in a trial of them. Get a dozen.

H.A. ROGERS CO., 87 Walker St., New York

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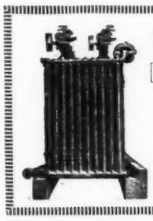

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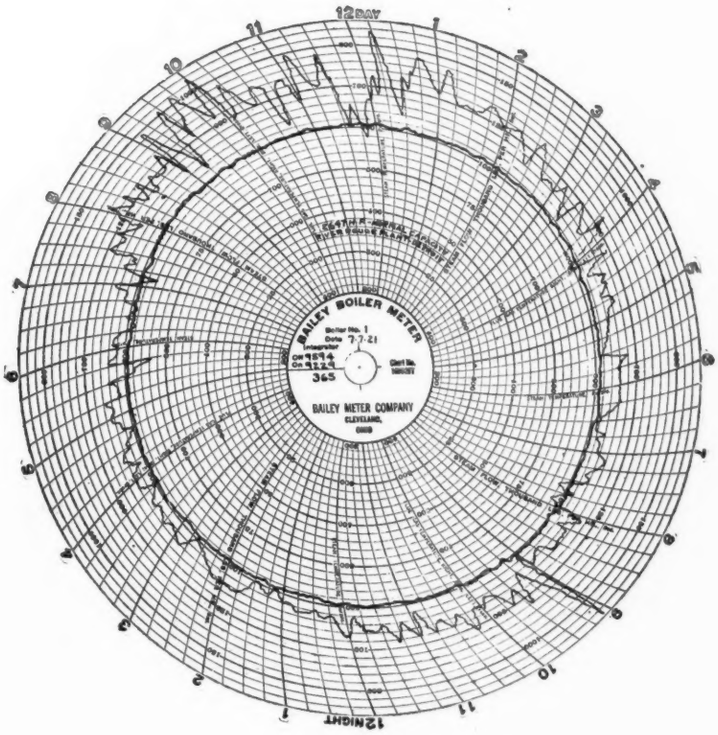

Constant Steam Temperatures Maintained with Elesco Superheaters at the Ford Motor Company River Rouge Plant

THE maintenance of superheated steam temperatures nearly constant under a wide range of boiler loads is impressively shown on this chart taken from one of the 2,647 H.P. vertical boilers at the River Rouge Plant of the Ford Motor Co.

The outside irregular line indicates the steam flow which under normal operation at 100% boiler rating is 82,586 lbs. per hour. It will be seen that this varies from 163,000 lbs. maximum 197.5% rating to 84,000 lbs. minimum 101.6% rating.

The even inside line indicates the steam temperature. At normal pressure (225 lbs. Gage) the approximate temperature of 200 deg. superheat is 600 deg. F. It will be noted that the variation in steam temperature is very slight, being:

615 deg. maximum 2.5% above normal to 588 deg. minimum. 2% below normal or a variation from maximum to minimum of but 4.5%.

Correct design and proper location of Elesco Superheater units in the gas path reduce variations in superheat to a negligible quantity.

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DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES

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Fuel Economy Is Impossible

with boiler tubes coated with scale

ROTO removes ALL thin patches of scale, like those shown above which escape ordinary small-bodied cleaners

Clean them with ROTO

Then Watch Coal Bills Fall

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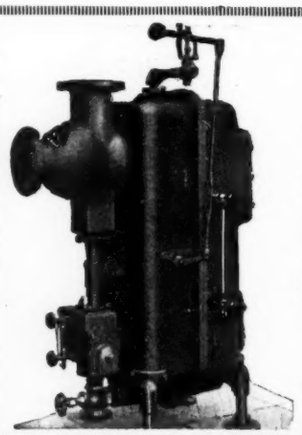

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Less Fuel Less Labor

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(51)

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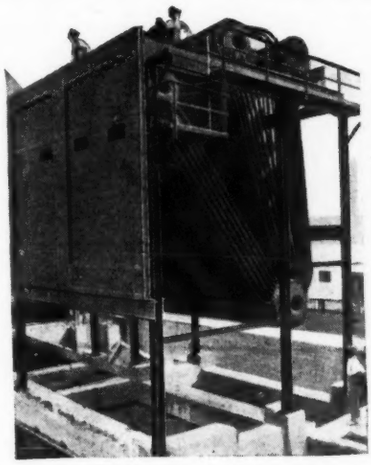

This picture shows a 1058-H.P. unit at Andrews Steel Co., Newport, Ky.

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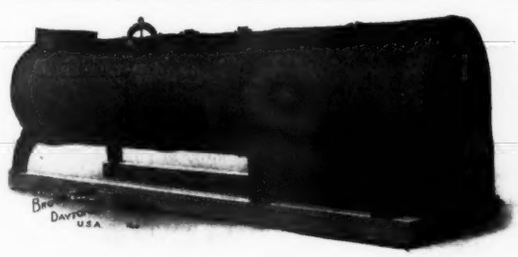

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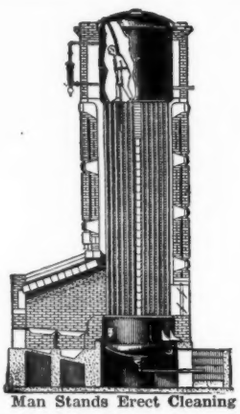

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Smith Horizontal Return Tubular and Smith Vertical Boilers conform in full to the A. S. M. E. Code and all State Codes.

Quality in material and workmanship the key-note. The care taken in building these boilers is reflected by their excellent performance in actual service.

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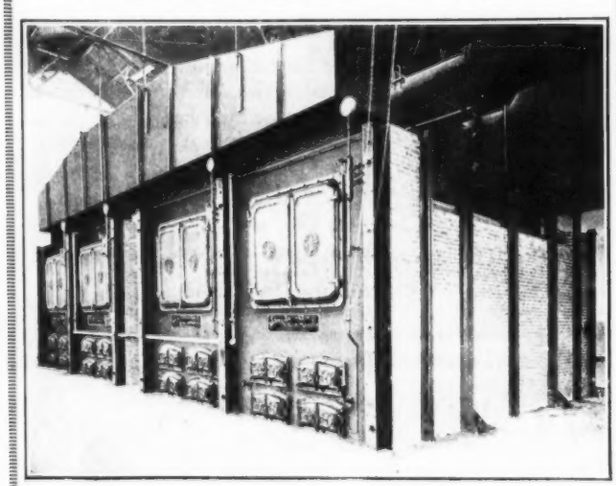

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UNIFLOW BOILERS

THE disengaging area or steam liberating surface in the Uniflow Boiler is larger than that of ordinary return tubular boilers. For this reason the upward steam velocity is about 25% less—that is, a Uniflow Boiler develops 33 1/3% more B.H.P. per sq. ft. of heating surface for the same upward steam velocity than an ordinary H.R.T. boiler.

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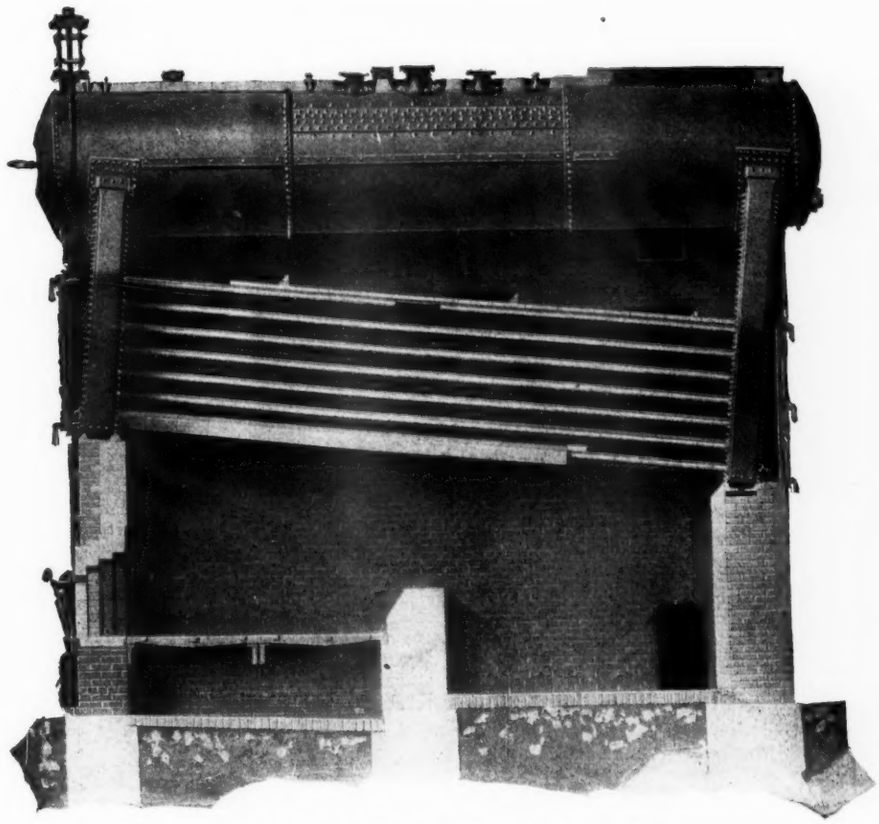

Erie City Horizontal Water Tube Boiler

Features of the Erie City Horizontal Water Tube Boiler

Free circulation of all the water in the boiler. Ample steam liberating surface. Large steam holding capacity. Proper amount of heating surface. The proper application of heated gases. Simplest possible arrangement for closing handhole openings. Constant and regular water levels. Internal and external parts convenient for cleaning and repairs. Design of boiler permits installations in minimum space. Minimum amount of brick required for settings. As to materials and construction, Erie City Boilers are "built better than specifications."

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That is an axiomatic truth that bears repeating. It is a principle that should never be lost sight of for an instant in purchasing a boiler. You might forget everything else, but you could not go far wrong if you bought your boiler on this basis.

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Let us lay before you the documentary evidence that Erie City Horizontal Water Tube Boilers are not only in Class A, but at the top of the class. Let us explain how we build them "better than code specifications."

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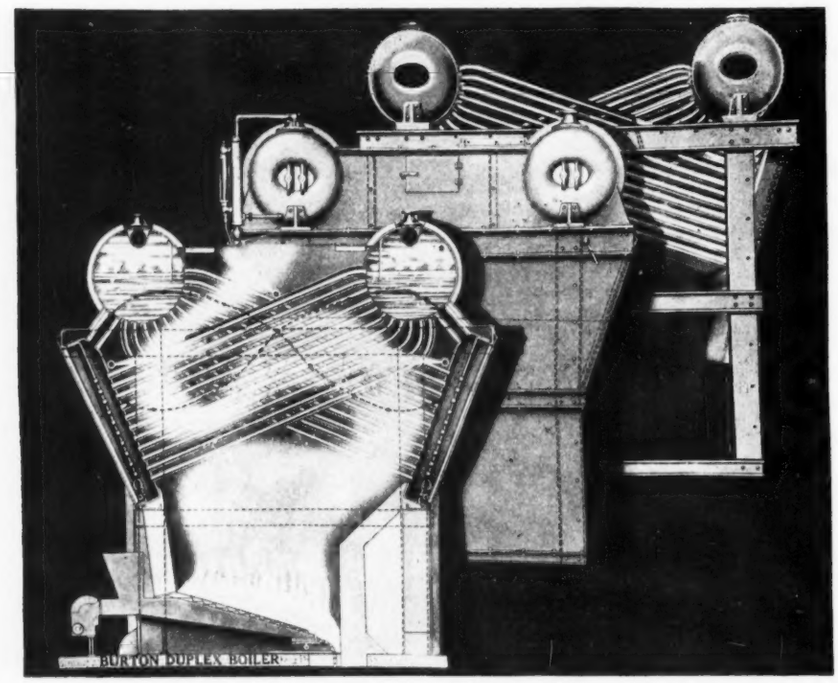
Also Manufacturers of the Erie City Pulverized Coal Equipment

Burton Duplex Water Tube Boilers



Copyright and Patent Pending

Opposite are three views that illustrate the simple and distinctive construction of the Burton Duplex Boilers. It consists of Two Drums and Criss-cross Tube surface. Duplex Boilers have great water-holding capacity and large volume steam space. The design permits larger capacity in same space for renewal boilers. Assembled in shop ready to place in steel frame, or assembled on job. Requires no large openings to boiler room. Proportioned to suit existing conditions. Fire-box steel headers and drums seamless tubes. A. S. M. E. code.

Tubes cleaned from within the drums, not necessary to remove tube caps for washing out. Tubes curved all same radius, one end only; any longer tube may be cut for replacement, removal of tubes from combustion chamber. Adaptable for oil or any stoker, large combustion volume. All Duplex Boilers are equipped with effective soot blowers. Two boilers in one setting and two passes in each boiler for the gasses. Fire tile baffle.

Write for further information

Note Horizontal Fig. ∞ Water Circulation

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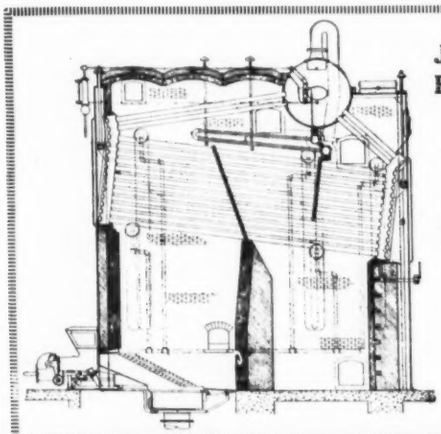

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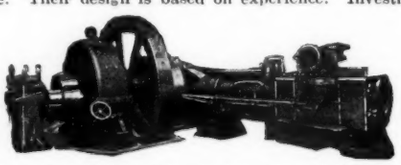

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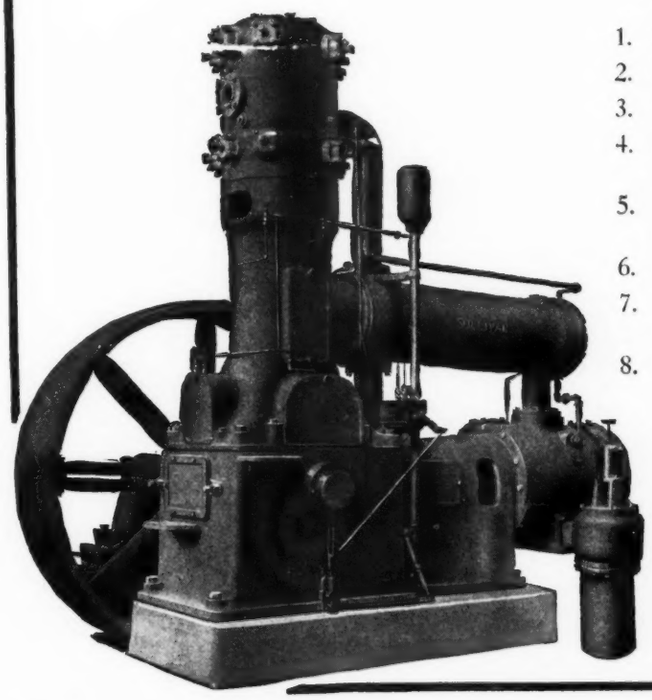

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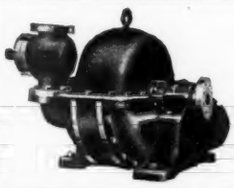

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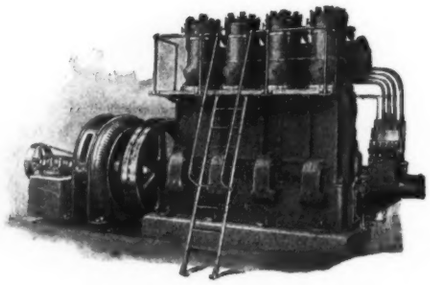
Wood and Walnut Sts., Chicago, Ill.

We send men and portable tools to your plant to rebore cylinders and ports and fit new pistons and valves. Contract work. Builders of Special Machinery. Send us your requirements.



Examples of Simplification

No gears.
No air compressor.
No valves to grind except small check valves.
No cams except for air starter.
No moving parts on cylinder heads.
No stuffing boxes on injection pump plungers.
Symmetrical cylinder heads and flat top pistons.
No moving parts in spray nozzle except check valves.
No mechanically operated valves except check valves.
No ignition devices, torches, hot metal or electric wires.

Think of the Parts Left Out

It's surprising the number of things that can be taken out of the old-fashioned Diesel Engine and still get the same results. For instance, look at the list of things which have been omitted from the Worthington Diesel Engine, two-cycle — solid injection type. Certainly this is a simpler engine and yet it is a true Diesel in operating cycle, economy and everything else.

WORTHINGTON

WORTHINGTON PUMP AND MACHINERY CORPORATION
Executive Offices: 115 Broadway, New York City
Branch Offices in 24 Large Cities

W. 150.4

Highest Non-Condensing Steam Economy

HARRISBURG
DUAL CLEARANCE
UNA-FLOW ENGINES
HARRISBURG CORPORATION
HARRISBURG FOUNDRY & MACHINE WORKS
Harrisburg, Pa.

AIR COMPRESSORS

All Sizes
All Types

No finer compressor made than a Bury Universal Variable Volumn 3-Cylinder, 2-Stage Air Compressor. Why not investigate?

Send for Bulletin

Bury Compressor Co.
1714 Cascade St., Erie, Pa.

For All Pressures

REEVES

Vertical Gas Engines, 18 to 300 H.P. Vertical gas engines, Vertical combination Gas Engine Driven Gas or Air Compressors. Vertical Gas or Air Compressors. These types cut foundation, installation, transportation and building costs approximately 40%.

Consulting and Contracting Engineers in Natural Gas and Oil

HOPE ENGINEERING & SUPPLY CO. Mt. Vernon, Ohio, U.S.A.

Branches Pittsburgh, Penna. Tulsa, Okla. Casper, Wyo.

THE TERRY TURBINE

is ideal for driving generators, pumps and fans for all service, because of its simplicity, efficiency and reliability. There are more than 4000 in operation.

THE TERRY STEAM TURBINE CO.
HARTFORD, CONN. T-434

Stumpf Una-Flow Engine Co., Inc.

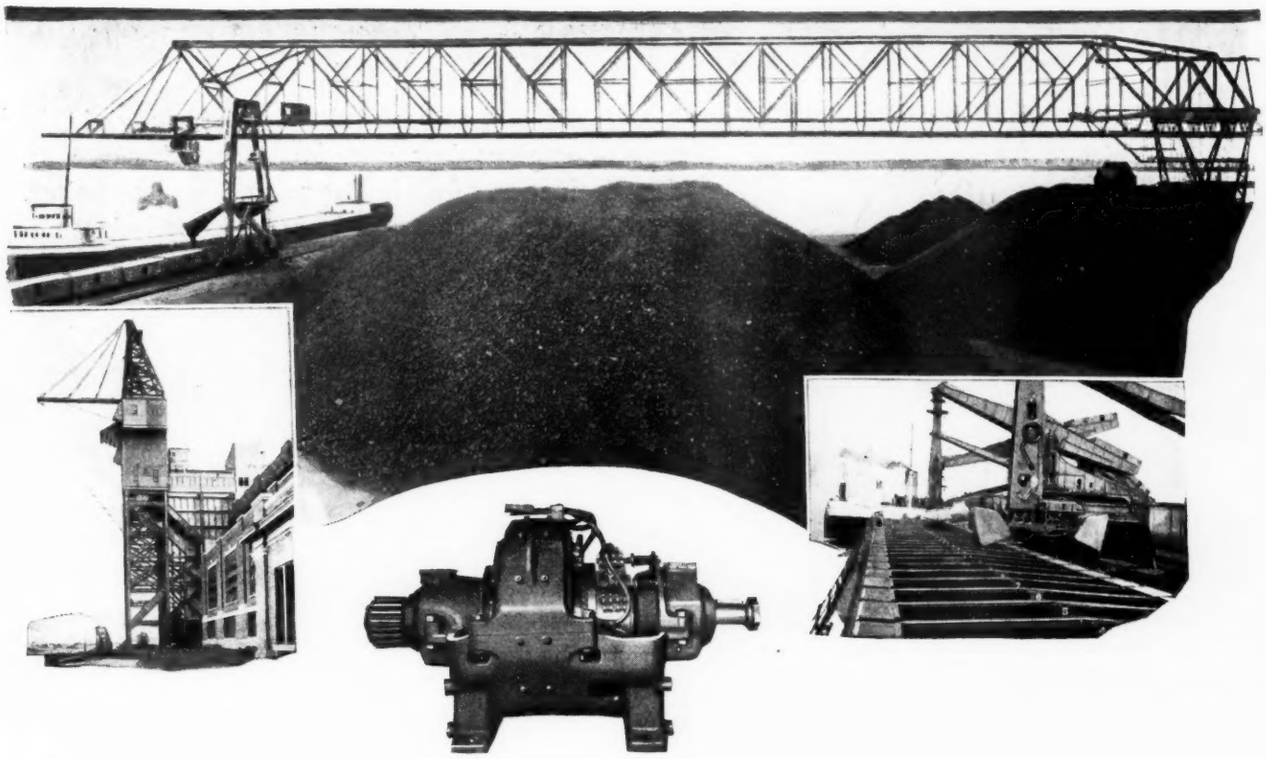
206 Genesee St., Syracuse, N. Y.
Send $5.00 for New Book and List of Licensees
STUMPFLOW DESIGNS—Economical Engines
Let Us Study Your Power Problems—Write Now

KERR STEAM TURBINES

For Generator Drive—Capacities 5 to 1000 KW.

KERR TURBINE COMPANY WELLSVILLE, N. Y.

The enormous bulk of coal handled today is a problem electricity alone can meet efficiently and economically



The right motor for the big jobs

Coal and Ore Bridges, Coal Unloading Towers, Hulett Unloaders—all kinds of grab-bucket handling machinery require the strongest, yet most practical type of electrical equipment. G-E Motors and Controllers are pioneers in this severe service.

Twelve tons at a bite is the way 4 G-E Motors handle the bucket of the 712 ft. coal bridge pictured at the top of this page.

In the coal unloading tower pictured here, G-E Equipment operates its 12-ton digging buckets and 6-ton clean-up buckets—handling 880 tons an hour. This tower makes about two round trips per minute over a hoisting distance of approximately 280 feet.

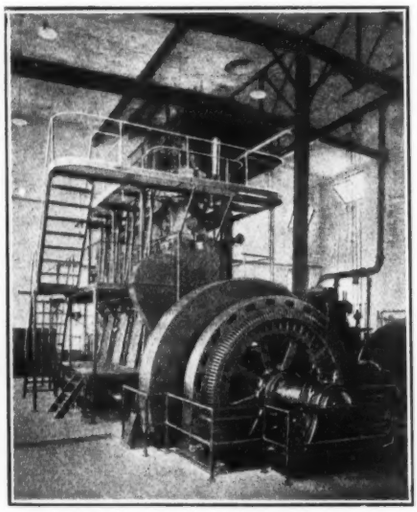
Since the earliest steps in the development of bulk material handling machinery, the General Electric Company has been called upon to develop and manufacture the electrical apparatus for driving and controlling the mechanical appliances of this class. Applications of G-E equipment to such service are portrayed in Bulletin 48026, mailed on request.

General Electric Company

General Office Schenectady, N.Y.

Sales Offices in all large cities

43B-65



750 Horsepower Unit in a Central Lighting Station

Low Fuel Bills
Low Attendance Cost
No Boiler Room Expense
Small Engine Room Expense

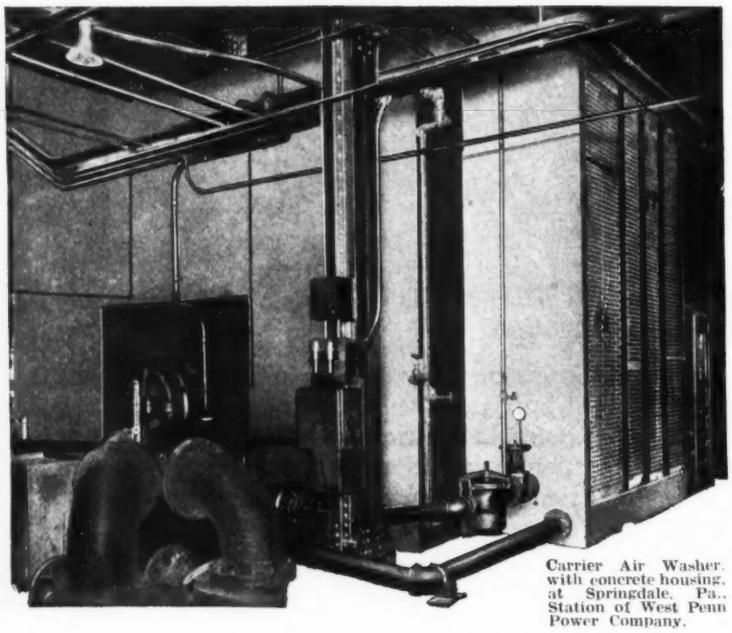
THESE are the possibilities of a McIntosh & Seymour Diesel installation.

Low fuel cost, because of the high economy of this type of engine; low attendance cost, because of the elimination of all boiler room labor; no boiler room expense, because of the complete elimination of all boilers and equipment; small engine room expense, because of the ruggedness and reliability of these units. All these make a low operating cost which is the aim of all power plant owners and operators.

DIESEL ENGINES IN SIZES FROM 100 B.H.P. TO 3000 B.H.P.

McINTOSH & SEYMOUR CORPORATION

MAIN OFFICE AND WORKS: AUBURN, NEW YORK



Carrier Air Washer, with concrete housing, at Springdale, Pa., Station of West Penn Power Company.

Many pailfuls of dirt are removed each week by passing the air through screens, sprays and eliminator plates.

Now West Penn Power Company generators need be cleaned out far less often

as the cooling air is cleansed and cooled by

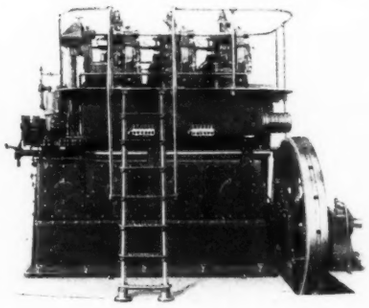
CARRIER AIR WASHERS

Costly dismantling for cleaning is necessary at far less frequent intervals and heavier loads can be carried without exceeding safe operating temperatures. Over 40 years of experience is at your service; just write Dept. No. 62.

Carrier Air Conditioning Company of America

152 Mortimer St., Buffalo, N. Y.

STANDARD DIESEL ENGINE



Reliable and Economical Power

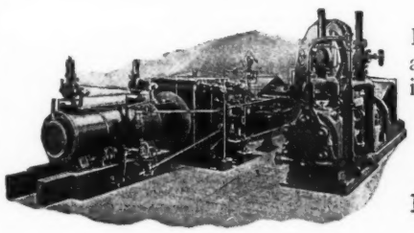
The HADFIELD-PENFIELD STEEL CO.

Bucyrus, Ohio

CHUSE ENGINES

Non-Releasing Corliss, Single Valve and Poppet Valve Uniflow Engines, for belting or direct connection to generating units, mine fans, blowers, air and ammonia compressors, in sizes from 100 to 1600 I. H. P.

Chuse Engine & Mfg. Co., Mattoon, Ill.



Refrigerating and Ice Making Machinery

Corliss Engines

Poppet Valve Engines

Vilter Tandem Compound Poppet Valve Engine direct connected to Ammonia Compressor.

The Vilter Manufacturing Co.
854-894 Clinton St., Milwaukee, Wisconsin

If your load has outgrown your plant, use—

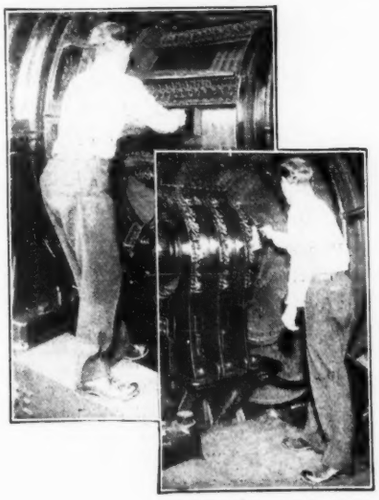
BENZ HIGH PRESSURE CRUDE OIL ENGINES

STEWART-SAYERS COMPANY
15 Maiden Lane, New York *Sole Distributors in America*

ENGINE REPAIRS

Let **UNDERWOOD** repair your engines and overhaul your plant. Repair crew and portable tools ready to make emergency repairs day or night in case of breakdown. All work first class by skilled machinists. We carry spare parts in stock. Write, wire or telephone.

H. B. Underwood Corp'n
Established 1870
1019 Hamilton St., Philadelphia, Pa.



IDEAL Commutator Resurfacer

Don't put off resurfacing commutators until commutator maintenance exceeds the cost of a number of Ideal Commutator Resurfacers. It's easy to grind commutators down in place and under full load—with the handy Ideal. Occasional use keeps commutators perfect.

High bars and high mica are quickly cut down, high spots are leveled easily.

It costs nothing to find out why plants of all sizes use so many Ideals. Take advantage of the generous free trial offer.

Ideal Commutator Dresser Co.
5325 N. Western Ave., Chicago

A manufactured stone, absolutely uniform in quality.

Ideal Commutator Dresser Co.,
5325 N. Western Ave., Chicago

Gentlemen: Please send me an Ideal Commutator Resurfacer for free trial. I want to use it on equipment as follows:

Approx. R.P.M.....Diameter of Commutator or Ring.....

Approx. Width of Commutator or Ring Surface.....

Approx. Distance Between Brush Sets.....Condition.....

Collector Ring or Commutator Material.....

Name .....Position .....

Company .....Company Address.....

City ..... State .....

WHAT AND WHERE TO BUY

Equipment, Apparatus and Supplies Used in the Power Plant Field with Names of Manufacturers and Distributors

Please refer to the Buying Section for addresses of concerns listed in this directory.
See Last Page for Alphabetical Index

Abrasives
Ideal Commutator Dresser Co.

Aftercoolers and Receivers, Air
Chicago Pneumatic Tool Co.

Alarms, Low Water
Elliott Co.
Lunkenheimer Co.
Reliance Gauge Column Co.
Wright-Austin Co.

Alternators
Allis-Chalmers Mfg. Co.

Alternators, Turbo
Allis-Chalmers Mfg. Co.
General Electric Co.
Kerr Turbine Co.
Terry Steam Turbine Co.

Ash Handling Machinery
(See Coal and Ash Handling Machinery)

Ash Tanks, Cast Iron
Green Engineering Co.

Ash Tanks, Steel
Heine Boiler Co.

Baffles, Boiler
Betson Plastic Fire Brick Co.
Engineer Co.
Johns-Manville, Inc.
Jointless Fire Brick Co.
King Refractories Co.

Baffles, Monolithic
Betson Plastic Fire Brick Co.
King Refractories Co.

Balancing Equipment, Turbine
Vibration Specialty Corp.

Bearings
American Injector Co.
Magnolia Metal Co.

Belting
Garlock Packing Co.
Greene, Tweed & Co.
Jeffrey Mfg. Co.
Quaker City Rubber Co.
Rhoads & Sons, J. E.
Schieren Co., Chas. A.

Belting Conveyor
Jeffrey Mfg. Co.

Belting Leather (Waterproof)
Schieren Co., Chas. A.

Belting, Link Leather
Schieren Co., Chas. A.

Belting, Rubber
Quaker City Rubber Co.

Bins
Brown Hoisting Machy. Co.
Green Engineering Co.

Blowers, CeCntrifugal
Coppus Eng. Corp.
Green Fuel Economizer Co.
Kerr Turbine Co.
Terry Steam Turbine Co.
Wing Mfg. Co., L. J.

Blowers, Fan
Carrier Air Conditioning Co.
Clarage Fan Co.
Coppus Eng Corp.
De Laval Steam Turbine Co.
Engineer Co.
General Electric Co.
Green Engineering Co.
Green Fuel Economizer Co.
Power Turbo-Blower Co.
Sturtevant Co., B. F.
Terry Steam Turbine Co.
Westinghouse E. & M. Co.
Wing Mfg. Co., L. J.

Blowers, Forced Draft
Carrier Air Conditioning Co.
Coppus Eng Corp.
Wing Mfg. Co., L. J.

Blowers, Induced Draft
Coppus Eng Corp.

Blowers, Steam Jet
Chesterton Co., A. W.
Eynon-Evans Mfg. Co.
McClave-Brooks Co
Schutte & Koerting Co.

Blowers, Turbine
Coppus Eng Corp.
Ingersoll-Rand Co.
Kerr Turbine Co.
Moore Steam Turbine Corp.
Power Turbo-Blower Co.
Sturtevant Co., B. F.
Terry Steam Turbine Co.
Wing Mfg. Co., L. J.

Boiler Insulation
Celite Products Co.
Johns-Manville, Inc.
Keasbey & Mattison Co.

Boiler Setting
Ballard, Sprague & Co.
Betson Plastic Fire Brick Co
Detrick Co., M. H.
Green Engineering Co.
Green Fire Brick Co., A. P.
Harbison-Walker Refractories Co.
Illinois Stoker Co.
Jointless Fire Brick Co.
Liptak Fire-Brick Arch Co.
Naismith & Son, Geo.

Boiler Tube Cap Reseating Machine
Lagonda Mfg. Co.

Boiler Tube Cleaners
(See Blowers Soot)
(See Tube Cleaners, Boiler)

Boiler Tubes
Boiler Tube Co. of Am.
Pittsburgh Steel Products Co.

Boilers, Heating
Brownell Co.
Oil City Boiler Works

Boilers, Portable
Erie City Iron Works

Boilers, Return Tubular
Bigelow Co.
Brownell Co.
Delany & Co., P.
Edge-Moor Iron Co.
Erie City Iron Wks.
Lebanon Boiler Works
Newburg Steam Boiler Works
Smith & Sons, Samuel
Union Iron Works
Vogt Machine Co., Henry

Boilers, Vertical Water Tube
Babcock & Wilcox Co.
Bigelow Co.
Erie City Iron Wks.
O'Brien Boiler Wks. Co., J.
Wickes Boiler Co.

Boilers, Water Tube
Abendroth & Root Mfg. Co.
Babcock & Wilcox Co.
Badenhausen, Phillips
Bethlehem Shipbuilding Corp.
Bigelow Co.
Connelly Boiler Co., D.
Erie City Iron Works
Heine Boiler Co.
Ladd Co., Geo. T.
Mohr & Sons, John
O'Brien Boiler Wks. Co., J.
Oil City Boiler Works
Page Boiler Co.
Springfield Boiler Co.
Union Iron Works
Vogt Machine Co., Henry

Books
McGraw-Hill Book Co.

Breechings
Connery & Co.
Littleford Bros.
Smith & Sons, Samuel

Brick, Fire
Betson Plastic Fire Brick Co.
Green Engineering Co.
Green Fire Brick Co., A. P.
Harbison-Walker Refractories Co.
King Refractories Co.

Brick, Insulating
Celite Products Co.

Bucket Carrier, Pivoted
Jeffrey Mfg. Co.
Webster Mfg. Co.

Buckets, Clam Shell
Brown Hoisting Machy. Co.
Orton & Steinbrenner Co.

Burners, Oil
Bethlehem Shipbuilding Corp.
Coen Co.
Forest & Sons, John

Bushings
Magnolia Metal Co.

Castings, Brass and Iron
Bethlehem Shipbuilding Corp.
Builders Iron Foundry
McClave-Brooks Co.
Neemes Bros.
Nelson Valve Co.

Castings, Grey Iron
Harrisburg Fdy. & Mach. Works

Cement, Asbestos
Keasbey & Mattison Co.

Cement, Iron
Smooth-On Mfg. Co.

Cement and Mortar for Fire Brick
Betson Plastic Fire Brick Co.
Green Fire Brick Co., A. P.
Johns-Manville Co.
Jointless Fire Brick Co.
King Refractories Co.

Cement, Pipe Joint
Johns-Manville, Inc.
Smooth-On Mfg. Co.

Chain Drive
Jeffrey Mfg. Co.
Morse Chain Co.

Chimneys (See Stacks)

Clamps, Hose
Strong, Carlisle & Hammond Co.

Clamps, Pipe
Yarnall-Waring Co.

Clutches, Friction
Allis-Chalmers Mfg. Co.
Caldwell Co., W. E.
Moore & White Co.

Coal
International Fuel & Iron Co.

Coal Agitators
Ellis Co., W. E.

Coal and Ash Handling Machinery
Brown Hoisting Machy. Co.
Combustion Engineering Corp
Detrick Co., M. H.
Gifford-Wood Co.
Godfrey Conveyor Corp.
Green Engineering Co.
Hagan Corp.
Hayward Co.
Hunt Co., C. W.
Jeffrey Mfg. Co.
Portable Machinery Co.
United Conveyors Corp.
Webster Mfg. Co.

Coal Bunkers
Brown Hoisting Machy. Co.
Green Engineering Co.

Coal Crushers
Brown Hoisting Machy. Co.
Fuller-Lehigh Co.
Jeffrey Mfg. Co.
Orton & Steinbrenner Co.
Webster Mfg. Co.
Worthington Pump & Mchy. Corp.

Coal Pulverizing Equipment
Combustion Engineering Corp.
Erie City Iron Wks.
Fuller-Lehigh Co.
Jeffrey Mfg. Co.

Cocks, Brass and Iron Body
Homestead Valve Mfg. Co.

Cocks, Gage
Jenkins Bros.

Cocks, Steam
Dart Mfg. Co., E. M.
Homestead Valve Mfg. Co.
Lunkenheimer Co.

Coke
International Fuel & Iron Co.

Combustion Chamber, Back Arch
Betson Plastic Fire Brick Co.
Detrick Co., M. H.
Green Fire Brick Co., A. P.
Jointless Fire Brick Co.

CO_2 Recorders and Flue Gas Analysis Instruments
Chadburn Engineering Co.
Foxboro Co.
Hays Corp., Jos. W.
Republic Flow Meters Co.
Yarnall-Waring Co.

Commutator Compound
Ohio Grease Co.

Commutator, Resurfacer
Ideal Commutator Dresser Co.

Commutators, Stone
Ideal Commutator Dresser Co.

Compressors, Air
Allis-Chalmers Mfg. Co.
Bury Compressor Co.
D'Olier Cent. Pump & M. Co.
Gardner Governor Co.
General Electric Co.
Ingersoll-Rand Co.
Pennsylvania Pump & Compressor Co.
Sullivan Machinery Co.
Worthington Pump & Mchy. Corp.

Compressors, Ammonia
Ingersoll-Rand Co.

Compressors, Gasoline Extraction
Sullivan Machinery Co.

Condensers
Allis-Chalmers Mfg. Co.
Bethlehem Shipbuilding Corp.
Davidson Co., M. T.
Elliott Co.
Griscom-Russell Co.
Ingersoll-Rand Co.
Schutte & Koerting Co.
Standard Water Systems Co. of N. J.
Westinghouse E. & M. Co.
Wheeler Mfg. Co., C. H.
Wheeler Cond'r & Eng. Co.
Worthington Pump & Mchy. Corp.

Condensers, Barometric and Combined
Elliott Co.
Ingersoll-Rand Co.

Condensers, Distilling
Bethlehem Shipbuilding Corp.
Ross Heater & Mfg. Co.

Condensers, Jet
Davidson Co., M. T.
Elliott Co.
Ingersoll-Rand Co.
Manistee Iron Works Co.
Wheeler Mfg. Co., C. H.

Condensers, Surface
Elliott Co.
Ingersoll-Rand Co.

Conduits, Underground
American District Steam Co.
Johns-Manville, Inc.

Controllers, Draft
Engineer Co.

Controllers, Electric
General Electric Co.
Westinghouse E. & M. Co.

Converters, Synchronous
Allis-Chalmers Mfg. Co.
Westinghouse E. & M. Co.

Conveyors, Belt
Brown Hoisting Machy. Co.
Jeffrey Mfg. Co.

Conveyors, Coal and Ash
(See Coal and Ash Handling Machinery)

Conveyors, Portable
Portable Machinery Co.

Coolers
Griscom-Russell Co.
Vogt Mach. Co., Henry

Coolers, Oil
Griscom-Russell Co.

Cooling Plants and Ponds
Binks Spray Equipment Co.
Carrier Air Conditioning Co.
Spray Engineering Co.
Yarnall-Waring Co.

Cooling Towers
Wheeler Mfg. Co., C. H.

Couplings, Flexible Shaft
Allis-Chalmers Mfg. Co.
Dexter Co., I. H.
Smith & Serrell

Couplings, Rigid
Smith & Serrell

Couplings, Shaft
Dexter Co., I. H.
Smith & Serrell

Covering, Boiler
Betson Plastic Fire Brick Co.
Celite Products Co.

Covering, Pipe
Celite Products Co.
Johns-Manville, Inc.
Keasbey & Mattison Co.
Ric-Wil Co.

Covering, Underground Steam Pipe
Ric-Wil Co.

Cranes
Brown Hoisting Machy. Co.
Godfrey Conveyor Corp.
Orton & Steinbrenner Co.

Cranes, Locomotive
Industrial Works

Crankpin Turning Machines, Portable
Underwood Corp., H. B.

Cut-Outs, Electric
General Electric Co.
Johns-Manville, Inc.

Cutters, Boiler Tube
(See Pipe Cutters)

Cylinder Boring Bars and Reboring
Underwood Corp., H. B.

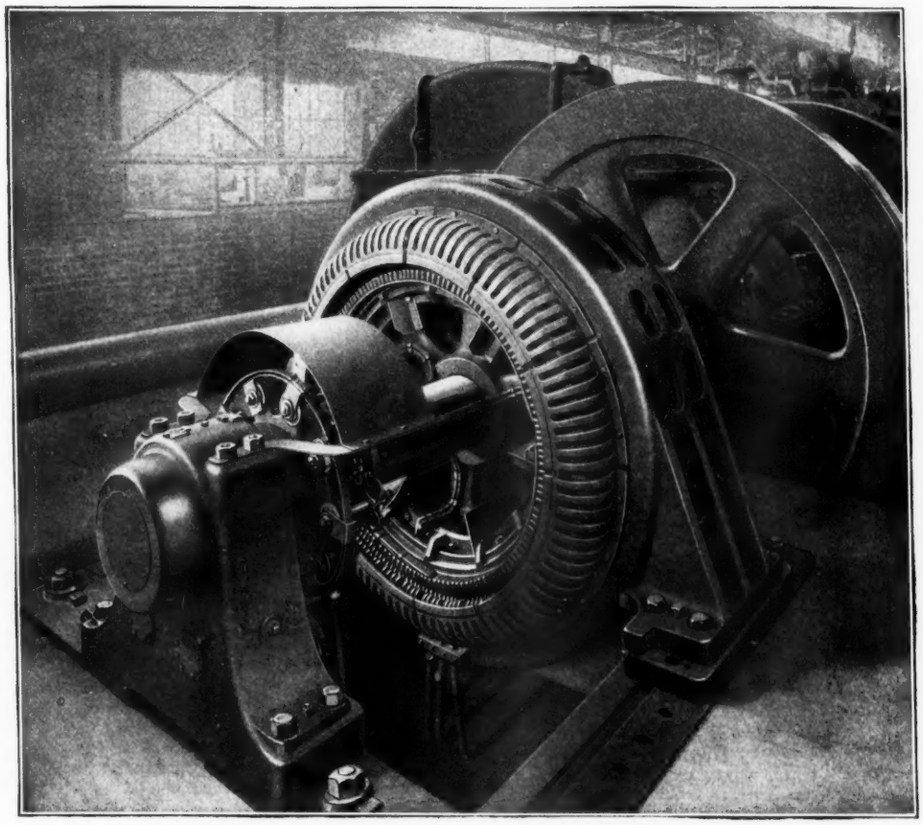
Dampers
Clarage Fan Co.

Dealers Machinery
Ames & Co., Chas. F.
Briggs, Maroni
Central Machy. & Equip Inspection Bureau
Duquesne Electric & Mfg. Co.
Harris Bros.
Kane, Thomas A.
Kehoe, Robt. P.
MacGovern & Co.
Machinery Utilities Co.
Nashville Industrial Corp.
O'Brien Mchy. Co.
Phoenix Utility Co.
Power Machy. Exchange
Randle Machinery Co.
Ross Power Equip. Co.
Sachsenmaier Co., George
Tippins & Sprengle

Die Stocks
Curtis & Curtis Co.
Toledo Pipe Theading Mach. Co.

Distilling Plants (Water)
Bethlehem Shipbuilding Corp
Griscom-Russell Co.
Sugar Apparatus Mfg. Co.

ALLIS-CHALMERS



1000 HP. 250 R.P.M. Sheet Mill Induction Motor

Sheet Mill Drive

An Allis-Chalmers Induction Motor with Automatic Liquid Slip Regulator Control giving unexcelled service in large Eastern Steel Plant.

ALLIS-CHALMERS PRODUCTS
Electrical Machinery
Steam Turbines
Steam Engines
Gas and Oil Engines
Hydraulic Turbines
Crushing and Cement Machinery
Mining Machinery

ALLIS-CHALMERS MANUFACTURING COMPANY

MILWAUKEE, WISCONSIN. U.S.A.

ALLIS-CHALMERS PRODUCTS
Flour and Saw Mill Machinery
Power Transmission Machinery
Pumping Engines-Centrifugal Pumps
Steam and Electric Hoists
Air Compressors - Air Brakes
Agricultural Machinery
Condensers

Doors, Ash Pit
Green Engineering Co.

Draft, Mechanical
(See Blowers, Fan)

Dressing, Belt
Cling Surface Co.
Keystone Lubricating Co.
Rhoads & Sons, J. E.
Texas Co.

Dressing, Rope
Cling Surface Co.

Drills
Chicago Pneumatic Tool Co
Ingersoll-Rand Co.
Jeffrey Mfg. Co.

Drop Forgings
Vogt Machine Co., Henry

Dynamometers
Wheeler Mfg. Co., C. H.

Dynamos (See Generators)

Economizers,
Green Fuel Economizer Co.
Sturtevant Co., B F

Ejectors
American Injector Co.
Chaplin-Fulton Mfg. Co.
Eynon-Evans Mfg. Co.
Lunkenheimer Co.
Schutte & Koerting Co.
Sherwood Mfg. Co.

Ejectors, Air
Elliott Company.

Ejectors, Sewerage
Blackburn-Smith Corp.

Electric Generating Sets, Steam Turbine
Allis-Chalmers Mfg. Co.
General Electric Co.
Moore Steam Turbine Co.
Sturtevant Co., B F
Terry Steam Turbine Co.

Elevators and Conveyors
Brown Hoisting Machy. Co.
Jeffrey Mfg. Co.
Orton & Steinbrenner Co.

Engineering Service
(See Directory)

Engine Repairs
Lammert & Mann Co.
Underwood Corp., H. B.

Engine Stops
Strong Carlisle & Hammond Co.

Engines, Diesel
Busch-Sulzer Bros.-Diesel Engine Co.
Fulton Iron Wks. Co.
Hadfield-Penfield Steel Co.
McIntosh & Seymour Corp.

Engines, Gas and Oil
Chicago Pneumatic Tool Co.
Cooper Co., C. & G.
Fulton Iron Wks. Co.
Hadfield-Penfield Steel Co.
Hope Eng. & Supply Co.
Ingersoll-Rand Co.
Sterling Engine Co.
Stewart-Sayers Co.

Engines, Pumping
Worthington Pump & Mchy. Corp.

Engines, Steam
Brownell Co.
Chicago Pneumatic Tool Co.
Chuse Eng. & Mfg. Co.
Clarage Fan Co.
Cooper Co., C. & G.
Erie City Iron Wks.
Fitchburg Steam Engine Co.
Fulton Iron Wks. Co.
Harrisburg Fdy. & Mach. Works
Oil City Boiler Works
Stumpf Una-Flow Engine Co.
Vilter Mfg. Co.
Worthington Pump & Mchy. Corp.

Engines, Una-Flow
Chuse Eng. & Mfg. Co.
Harrisburg Fdry. & Mach. Works
Stumpf Una-Flow Engine Co.

Evaporators
Bethlehem Shipbuilding Corp.
Griscom-Russell Co.
Standard Water Systems Co. of N. J.
Sugar Apparatus Mfg. Co.
Wheeler Cond. & Eng. Co.

Exhaust Heads
Direct Separator Co.
Hoppes Mfg. Co.
Ohio Body & Blower Co.
Patterson-Kelley Co.
Watson & McDaniel Co.

Expansion Joints
American District Steam Co.
Griscom-Russell Co.
Nelson Valve Co.
Ross Heater & Mfg. Co.

Fans, Exhaust and Ventilator
(See Blowers, Fan)

Feed Water, Make Up Plants
Conveyors Corp. of America
Griscom-Russell Co.
Ohio Body & Blower Co.

Filters, Feed Water
Blackburn-Smith Corp.
Elliott Co.
Griscom-Russell Co.
Lagonda Mfg. Co.

Filters, Oil
Blackburn-Smith Corp.
Elliott Co.
Nugent & Co., Wm. W.
Richardson-Phenix Div.
Wayne Tank & Pump Co.

Filters, Oil System
Richardson-Phenix Div.

Filters, Oil, Removal
Permutit Co.

Filters, Water
International Filter Co.
Permutit Co.
Scaife & Sons Co., Wm. B.

Fire Brick Arches
Detrick Co., M. H.
Liptak Fire-Brick Arch Co.

Fittings, Ammonia
Greene, Tweed & Co.
Reading Valve & Fittings Div.
Vogt Machine Co., Henry
York Mfg. Co.

Fittings, Steel
Crane Co.
Pittsburgh Piping & Equipt. Co.
Reading Valve & Fittings Div.

Flanges
Dart Mfg. Co., E. M.
Jefferson Union Co.
Jenkins Bros.
Pittsburgh Piping & Equipt. Co.
Reading Valve & Fittings Div.
Vogt Machine Co., Henry

Floats
Reliance Gauge Column Co.

Floor Gratings
Irving Iron Wks. Co.

Flooring, Industrial
Johns-Manville, Inc.

Forges
Carrier Air Conditioning Co.

Foundations, Machinery
Ballard, Sprague & Co.

Fuel Oil Systems
Bethlehem Shipbuilding Corp.
Coen Co.
Foerst & Sons, John
Wayne Tank & Pump Co.

Furnace Door Arch
Betson Plastic Fire Brick Co.
Detrick Co., M. H.
Green Engineering Co.
Illinois Stoker Co.
Jointless Fire Brick Co.

Furnace Linings
Betson Plastic Fire Brick Co.
Green Fire Brick Co., A. P.
Jointless Fire Brick Co.
King Refractories Co.

Furnaces
Automatic Furnace Co.
Cokal Stoker Corporation
Detroit Stoker Co.
Green Engineering Co.
Hofft Co., M. A.
Illinois Stoker Co.
McClave Brooks Co.
Roach Stoker Co.
General Electric Co.

Fuses
General Electric Co.
Johns-Manville, Inc.
Westinghouse E. & M. Co.

Gage Cocks
(See Cocks, Gage)

Gage Glass, Guards and Shields
Rogers Co., H. A.

Gage Glasses
Advance Packing & Sup. Co.
Chesterton Co., A. W.
Ernst & Co.
Garlock Packing Co.
Libbey Glass Mfg. Co.
Rogers Co., H. A.

Gages, Differential
Bailey Meter Co.

Gages, Draft
Bailey Meter Co.
Bristol Co.
Hays Corp., Jos. W.

Gages, Pressure
Ashton Valve Co.
Bristol Co.
Foxboro Co.

Gages, Recording
Bristol Co.
Foxboro Co.
Hays Corporation, Jos. W.

Gages, Vacuum
Bristol Co.
Foxboro Co.
Greene, Tweed & Co.

Gages, Water
Ernst & Co.
Greene, Tweed & Co.
Jenkins Bros.
Reliance Gauge Column Co.

Gas Exhausters
General Electric Co.
Ingersoll-Rand Co.

Gaskets
Advance Packing & Sup. Co.
Eureka Packing Co.
Garlock Packing Co.
Goetze Gasket & Packing Co.
Greene, Tweed & Co.
Jenkins Bros.
Keasbey & Mattison Co.
Smooth-On Mfg. Co.

Gates, Coal & Ash Bin
Conveyors Corp. of America
Green Engineering Co.
Jeffrey Mfg. Co.

Gates, Sluice
Chapman Valve Mfg. Co.

Gears
De Laval Steam Turbine Co.
Earle Gear & Machine Co.
General Electric Co.
Jeffrey Mfg. Co.

Gears, Reduction
Moore Steam Turbine Co.

Generator Coolers
Carrier Air Conditioning Co.
Spray Engineering Co.

Generators, Electric
General Electric Co.
Kerr Turbine Co.
Terry Steam Turbine Co.
Westinghouse E. & M. Co.

Governors, Pressure
Northern Equipment Co.

Governors, Pump
Chaplin-Fulton Mfg. Co.
Davis Regulator Co., G. M.
Northern Equipment Co.
Squires Co. C. E.
Strong, Carlisle & Hammond Co.
Wright-Austin Co.

Graphite
Garlock Packing Co.
Greene, Tweed & Co.

Grate Bars
Cokal Stoker Corp.

Grates
Babcock & Wilcox Co.
Combustion Eng. Corp.
Cyclone Grate Bar Co.
Delany & Co., P.
Flynn & Emrich
Green Engineering Co.
Hofft M. A., Co.
Marion Mch. Fdry. & Supply Co.
McClave-Brooks Co.
Neemes Bros.
Newburgh Steam Boiler Wks.
Perfection Grate & Supply Co.
Roach Stoker Co.
Valley Iron Works
Vogt Machine Co., Henry
Washburn & Granger

Grease
Cooks Sons Co., Adam
Keystone Lubricating Co.
Ohio Grease Co.
Texas Co.

Grease Extractors
Blackburn-Smith Corp.
Elliott Co.
Griscom-Russell Co.
Lagonda Mfg. Co.

Grinders, Air & Elec. Portable
Chicago Pneumatic Tool Co.

Hammers, Pneumatic
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.

Hangers, Shafting
Cresson-Morris Co.
Jeffrey Mfg. Co.
Valley Iron Works

Heaters, Domestic
King Constr. Co.
Stewart Heater Co.

Heaters Feed Water
Bethlehem Shipbuilding Corp.
Elliott Co.
Griscom-Russell Co.
H. S. B. W. Cochrane Corp.
Hoppes Mfg. Co.
King Constr. Co.
Patterson-Kelley Co.
Permutit Co.
Standard Water Systems Co. of N. J.
Stewart Heater Co.
Webster & Co., Warren
Wheeler Cond. & Eng. Co.

Heaters, Oil
Bethlehem Shipbuilding Corp.
Griscom-Russell Co.

Heating and Ventilating Systems
Carrier Air Conditioning Co.
Clarage Fan Co.
Webster & Co., Warren

Heating Specialties
American District Steam Co.

Hoists
Godfrey Conveyor Corp.

Hoists, Air
Chicago Pneumatic Tool Co.

Hoists, Ash
Washburn & Granger

Hoists, Portable, Air
Sullivan Machinery Co.

Hoists, Steam
Sullivan Machinery Co.

Hoppers, Coal and Ash
Green Engineering Co.
Jeffrey Mfg. Co.

Hose, Air
Chicago Pneumatic Tool Co.

Hose, Boiler Cleaning
Lagonda Mfg. Co.

Hose, Rubber
Quaker City Rubber Co.

Ice Machine Repairs
Underwood Corp., H. B.

Ice and Refrigerating Machinery, (See Refrigerating Machinery)

Indicators, Speed
Biddle, James G

Indicators, Steam Engine
Robertson & Sons, Jos. L.

Injectors
American Injector Co.
Eynon-Evans Co.
Jenkins Bros.
Lunkenheimer Co.
Manzel Bros. Co
Sherwood Mfg. Co.

Keys, Machine Self-fitting
Smith & Serrell

Lamps, Arc
General Electric Co.

Lamps, Incandescent
General Electric Co.

Lightning Arresters
Westinghouse E. & M. Co.

Lightning Rods
Custodis Chimney Constr. Co., Alphons

Lubricants
Cook's Sons, Adam
Keystone Lubricating Co.
Texas Co.

Lubricators, Cylinder
Greene, Tweed & Co.
Keystone Lubricating Co.
Ohio Grease Co.
Sherwood Mfg. Co.

Lubricators, Force Feed
Greene, Tweed & Co.
Ingersoll-Rand Co.
Powell Co., Wm.
Richardson-Phenix Div.

Lubricators, Sight Flow
Richardson-Phenix Div.

Machine Work, Special
Griscom-Russell Co.
Lammert & Mann Co.

Metal, Bearing
American Injector Co.
Magnolia Metal Co.

Meters, Air
Bailey Meter Co.
Builders Iron Foundry
General Electric Co.
Republic Flow Meters Co.

Meters, Boiler
Bailey Meter Co.
Republic Flow Meters Co.

Meters, Coal
Bailey Meter Co.

Meters, Electric
Westinghouse E. & M. Co.

Meters, Feed Water
Bailey Meter Co.
Builders Iron Fdry.
Republic Flow Meters Co.
Yarnall-Waring Co.

Meters, Flow
Cory & Son, Chas.
Bailey Meter Co.
Builders Iron Fdry.
Republic Flow Meters Co.
Yarnall-Waring Co.

Meters, Gas
Bailey Meter Co.
Builders Iron Foundry
General Electric Co.
Republic Flow Meters Co.

Meters, Oil
Builders Iron Foundry
General Electric Co.
Republic Flow Meters Co.

Meters, Steam
American District Steam Co.
Bailey Meter Co.
Builders Iron Foundry
General Electric Co.
Republic Flow Meters Co.

Meters V-Notch
Bailey Meter Co.
Hoppes Mfg. Co.
H. S. B. W. Cochrane Corp
Yarnall-Waring Co.

Meters, Water
Bailey Meter Co.
Builders Iron Foundry
General Electric Co.
H. S. B. W. Cochrane Corp.
Hoppes Mfg. Co.
Republic Flow Meters Co.
Yarnall-Waring Co.

Motors, Electric
Crocker-Wheeler Co.
Electric Machinery Mfg. Co.
General Electric Co.
Westinghouse E. & M. Co.

Motors, Water
Roto Co.

Oil and Gasolene Storage Systems
Wayne Tank & Pump Co.

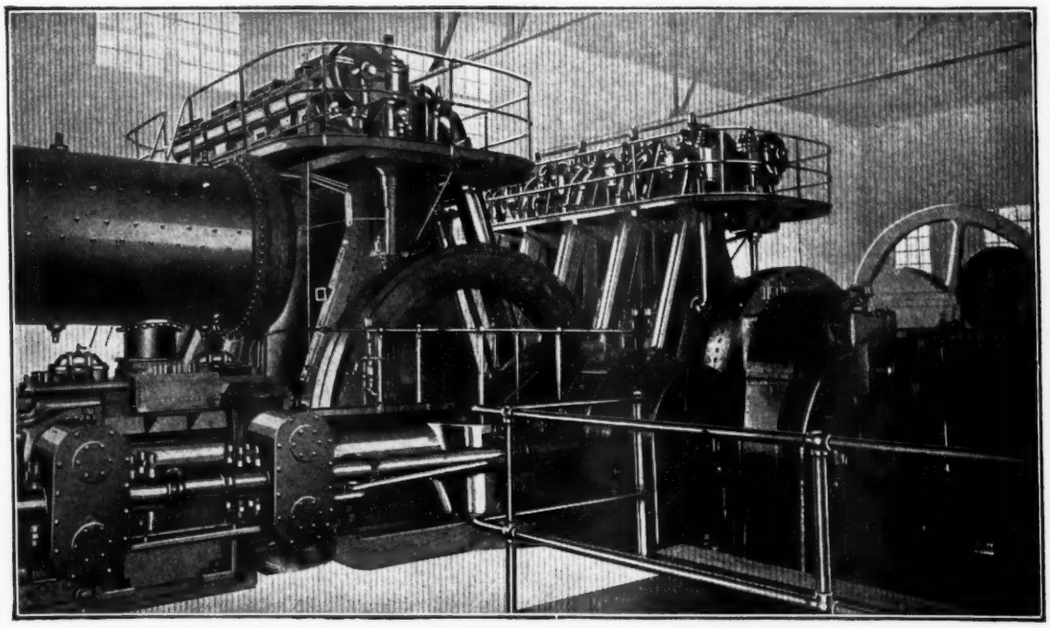
Oil, Fuel
Texas Co.

Oil and Grease Cups
American Injector Co.
Cooks Sons Co., Adam
Keystone Lubricating Co.
Lunkenheimer Co.
Ohio Grease Co.
Powell Co., Wm.

Oil, Lubricating
Cook's Sons, Adam
Keystone Lubricating Co.
Texas Co.

Oiling Devices and Systems
Elliott Co.
Nugent & Co., Wm. W.
Richardson-Phenix Div.

Oil Reclaimers
Richardson-Phenix Div.



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Two 550-horsepower Fulton-Diesels were installed as power units in a city waterworks in 1914. With a growth of the city that demanded more power, a third Fulton-Diesel of the same capacity was added to the other two in 1916. Today this Fulton-equipped plant of 1650 horsepower is one of the largest Diesel-driven waterworks in America.

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Plant engineers find the Fulton-Diesel ideal to operate and maintain at high efficiency. To assist them in developing the best type of Diesel practice our supervising engineers make regular visits to all Fulton-Diesel installations. All plant engineers interested in Fulton-Diesel operation are cordially invited to visit our shops at St. Louis.

On requests from executives and engineers, our latest illustrated book describing the Fulton-Diesel will be mailed free and postpaid. Our staff of engineers is ready at all times to advise on any power problem—anywhere—without charge or obligation.

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FULTON DIESEL

Oilers, Telescopic & Centrifugal
Richardson-Phenix Div.

Oilers, Sight Feed & Multiple
Richardson-Phenix Div.

Packing, Asbestos
Advance Pkg. & Supply Co.
Chesterton Co., A. W.
Crandall Packing Co.
Johns-Manville, Inc.
Keasbey & Mattison Co.

Packing, Cylinder
Chesterton Co., A. W.

Packing, Hydraulic
Advance Packing & Sup. Co.
Chesterton Co., A. W.
Crandall Packing Co.
Eureka Packing Co.
Garlock Packing Co.
Goetze Gasket & Pkg. Co.
Walker & Co., Ltd., James

Packing, Metallic
Crandall Packing Co.
Eureka Packing Co.
France Packing Co.
Garlock Packing Co.
Merrill & Co., Wm. B.
Walker & Co., Ltd., James

Packing, Piston
Chesterton Co., A. W.
Johns-Manville, Inc.

Packing, Pump Valve
Garlock Packing Co.
Johns-Manville, Inc.

Packing, Rod
Chesterton Co., A. W.
Crandall Packing Co.
Eureka Packing Co.
France Packing Co.
Garlock Packing Co.
Goetze Gasket & Pkg. Co.
Greene, Tweed & Co.
Johns-Manville, Inc.
Merrill & Co., Wm. B.
Quaker City Rubber Co.

Packing Sheet
Advance Packing & Sup. Co.
Crandall Packing Co.
Eureka Packing Co.
Garlock Packing Co.
Greene, Tweed & Co.
Jenkins Bros.
Johns-Manville, Inc.
Keasbey & Mattison Co.
Quaker City Rubber Co.
Walker & Co., Ltd., James

Packing, Valve Stem
Crandall Packing Co.
Eureka Packing Co.
France Packing Co.
Garlock Packing Co.

Pipe
Dougherty Co., M. J.
National Valve & Mfg. Co.

Pipe Bending
Dougherty Co., M. J.
National Valve & Mfg. Co.
Pittsburgh Piping & Equipt. Co.

Pipe Coils
Abendroth & Root Mfg. Co.
Superheater Co.

Pipe Cutting and Threading Machines
Curtis & Curtis Co.
Toledo Pipe Threading Mach. Co.
Trimont Mfg. Co.

Pipe Fittings
Dougherty Co., M. J.
Jefferson Union Co.
Pittsburgh Piping & Equipt. Co.

Pipe Headers, Welded
Dougherty Co., M. J.

Piping, Contractors
Dougherty Co., M. J.
National Valve & Mfg. Co.

Piping Fabricators
Dougherty Co., M. J.
National Valve & Mfg. Co.

Piping, High Pressure
Dougherty Co., M. J.
National Valve & Mfg. Co.
Pitsburgh Piping & Equipt. Co.

Planimeters
Robertson & Sons, Jos. L.

Plant Communication System
Cory & Son, Inc., Chas.

Pneumatic Tools
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.

Power Transmission Machinery
Allis-Chalmers Mfg. Co.
Cresson-Morris Co
Morse Chain Co.

Primers, Pump
Barrett, Haentjens & Co.

Psychrometers, Recording
Foxboro Co.

Pulleys
Caldwell Co., W. E.
Greene, Tweed & Co.
Jeffrey Mfg. Co.
Valley Iron Works

Pumps, Air
Elliott Co.
Wheeler Condenser & Eng. Co.
Wheeler Mfg. Co., C. H.

Pumps, Boiler Feed
Allis-Chalmers Mfg. Co.
Bethlehem Shipbuilding Corp.
Coppus Eng Corp.
Dean Bros. Steam Pump Wks.
Earle Gear & Machine Co.
Ingersoll-Rand Co.
Lea Courtney Co.
Manistee Iron Works Co.
Moore Steam Turbine Corp.
Morris Machine Works
Platt Iron Works
Warren Steam Pump Co.

Pumps, Centrifugal
Alberger Pump & Condenser Co.
Allis-Chalmers Mfg. Co.
Carrier Air Conditioning Co.
Coppus Eng Corp.
De Laval Steam Turbine Co.
D'Olier Centrifugal Pump & Machine Co.
Earle Gear & Machine Co.
Ingersoll-Rand Co.
Lea Courtney Co.
Manistee Iron Works Co.
Moore Steam Turbine Corp.
Morris Machine Works
Pennsylvania Pump & Compressor Co.
Taber Pump Co.
Terry Steam Turbine Co.
Worthington Pump & Mchy. Corp.

Pumps, Condenser
Elliott Co.

Pumps, Elevator
Lea Courtney Co.
McGowan Co., J. H.

Pumps, Fire
Lea Courtney Co.

Pumps, Force Feed (See Lubricators)

Pumps, Hydraulic Pressure
Bethlehem Shipbuilding Corp.

Pumps, Mine
Allis-Chalmers Mfg. Co.
Ingersoll-Rand Co.
Manistee Iron Works Co.

Pumps, Oil
Bethlehem Shipbuilding Corp.
McGowan Co., J. H.
Sherwood Mfg. Co.
Worthington Pump & Mchy. Corp.

Pumps, Power
King Constr. Co.
McGowan Co., J. H.
Platt Iron Works
Stewart Heater Co.
Warren Steam Pump Co.

Pumps, Rotary
Taber Pump Co.

Pumps, Steam
Davidson Co., M. T.
Gardner Governor Co.
McGowan Co., J. H.
Manistee Iron Works Co.
Pennsylvania Pump & Compressor Co.
Warren Steam Pump Co.
Worthington Pump & Mchy. Corp.

Pumps, Turbine
Allis-Chalmers Co.
Bethlehem Shipbuilding Corp.
Kerr Turbine Co.
Manistee Iron Works Co.
Moore Steam Turbine Corp.
Standard Turbine Corp.
Terry Steam Turbine Co.

Pumps, Vacuum
Bethlehem Shipbuilding Corp.
Davidson Co., M. T.
Dean Bros. Steam Pump Wks.
Elliott Co.
Ingersoll-Rand Co.
Manistee Iron Works Co.
Sullivan Machinery Co.
Warren Steam Pump Co.

Pumps, Water-Works
Allis-Chalmers Mfg. Co.
Lea-Courtney Co.
Manistee Iron Works Co.

Purifiers Feed Water
Blackburn-Smith Corp.
H. S. B. W. Cochrane Corp.
Hoppes Mfg. Co.
International Filter Co.
Permutit Co.
Webster & Co., Warren
Yarnall-Waring Co.

Purifiers, Oil
Industrial Products Co.

Purifiers, Steam
Andrews-Bradshaw Co.

Pyrometers
Bristol Co.
Hays Corp., Jos. W.
Taylor Instrument Co.'s

Refrigerating Machinery
Vilter Mfg. Co.
Vogt Machine Co., Henry
York Mfg. Co.

Regulators, Damper, Draft and Fan
Carrick Engineering Co.
Hagan Corp.
Robertson & Sons, Jas. L.
Wing Mfg. Co., L. J.

Regulators, Blast Furnace Gas
Hagan Corp.

Regulators Feed Water
Elliott Co.
Mason Regulator Co.
Northern Equipment Co.
Squires Co., C. E.
Wing Mfg. Co., L. J.

Regulators, Gas
Hagan Corp.

Regulators, Pressure
Carrick Eng. Co.
Chaplin-Fulton Mfg. Co.
Crane Co.
Davis Regulator Co., G. M.
d'Estes Co., Julian
Engineer Co.
Hagan Corp.
Mason Regulator Co.
Squires Co., C. E.
Strong, Carlisle & Hammond Co.
Taylor Instrument Co's.
Watson & McDaniel Co.

Regulators, Pump
d'Estes Co., Julian
Edward Valve & Mfg. Co.
Hagan Corp.
Mason Regulator Co.
Northern Equipment Co.
Squires Co., C. E.
Strong, Carlisle & Hammond Co.

Regulators, Stoker
Hagan Corp.

Regulators, Temperature
Bristol Co.
Hagan Corp.
Powers Regulator Co.
Sarco Co.

Reservoirs, Oil
Coatesville Boiler Wks.
Elliott Co.

Rheostats
General Electric Co.

Rope
American Mfg. Co.

Rope Transmission
American Mfg. Co
Hunt Co., C. W.

Rope, Wire
American Steel & Wire Co.

Rubber Goods
Quaker City Rubber Co.

Second-hand Equipment
Ames & Co., Chas. F.
Briggs, Marvin
Central Machy. & Equip. Inspection Bureau
Duquesne Electric & Mfg. Co.
Harris Bros.
Kane, Thomas A.
Kehoe, Robt. P.
Machinery Utilities Co.
MacGovern & Co.
Nashville Industrial Corp.
O'Brien Mchy. Co.
Phoenix Utility Co.
Power Machy. Exchange
Randle Machinery Co.
Ross Power Equip. Co.
Sachsenmaier Co., George
Tippins & Sprengle

Separators, Air
Direct Separator Co.
Elliott Company.
Griscom-Russell Co.
Ohio Body & Blower Co.

Separators, Ammonia
Elliott Co.
Gifford-Wood Co.
Jeffrey Mfg. Co.
Ohio Body & Blower Co.
Strong, Carlisle & Hammond Co.
United Machine & Mfg. Co.

Separators, Oil
Crane Co.
Direct Separator Co.
Elliott Co.
Griscom-Russell Co.
H. S. B. W. Cochrane Corp.
Hoppes Mfg. Co.
Industrial Products Co.
Ohio Body & Blower Co.
Robertson & Sons, Jas. L.
Strong, Carlisle & Hammond Co.
United Machine & Mfg. Co.
Wright-Austin Co.

Separators, Steam
American District Steam Co.
Andrews-Bradshaw Co.
Crane Co.
De Laval Separator Co.
Direct Separator Co.
Elliott Co.
Griscom-Russell Co.
H. S. B. W. Cochrane Corp.
Hoppes Mfg. Co.
Nicholson & Co., W. H.
Patterson-Kelley Co.
Robertson & Sons, Jas. L.
Strong, Carlisle & Hammond Co.
United Machine & Mfg. Co.
Wright-Austin Co.

Shafting
Cresson-Morris Co.
Valley Iron Works

Skimmers, Boiler
Yarnall-Waring Co.

Spray Nozzles (See Cooling Plants and Ponds)

Stacks, Metal
Heine Boiler Co.
Littleford Bros.
Smith & Sons, Samuel
Union Iron Works

Stacks, Radial Brick
American Chimney Corp.
Ballard, Sprague & Co.
Custodus Chimney Constr. Co., Alphons

Stair Treads, Non Slipping
Irving Iron Works Co.

Steel Plate Work
Erie City Iron Wks.
Heine Boiler Co.
Union Iron Works

Stokers, Chain and Traveling Grate
Babcock & Wilcox Co.
Combustion Engineering Corp.
Green Engineering Co
Illinois Stoker Co.
United Machine & Mfg. Co.

Stokers, Hand Operated
Cokal Stoker Corporation
Flynn & Emrich
Gibby Engineering Co.
Hofft Co., M. A.
Marion Machine Foundry & Supply Co.
McClave-Brooks Co.
Perfection Grate & Supply Co.
Valley Iron Works
Vogt Bros. Mfg. Co.

Stokers, Overfeed, Front Inclined and "V" Types
Detroit Stoker Co.
McClave-Brooks Co
Westinghouse E. & M. Co.

Stokers, Underfeed, Multiple Retort
American Engineering Co.
Detroit Stoker Co.

Riley Stoker Co., Sanford
Westinghouse E. & M. Co.

Stokers, Underfeed, Single Retort
Combustion Engineering Corp.
Detroit Stoker Co.

Stops, Engine
Strong, Carlisle & Hammond Co.

Strainers, Oil
Bethlehem Shipbuilding Corp.
Elliott Co.
Griscom-Russell Co.
Richardson-Phenix Div.
Sarco Co.

Strainers, Pump Suction
Elliott Co.

Strainers, Water
Elliott Co.
Sarco Co.

Superheaters
Babcock & Wilcox Co.
Heine Boiler Co.
Power Specialty Co.
Superheater Co.

Switchboards
General Electric Co.
Westinghouse E. & M. Co.

Switches and Circuit Breakers, Electric
General Electric Co.
Westinghouse E. & M. Co.

Tachometers
Biddle, James G.
Foxboro Co.

Tanks
Brownell Co.
Caldwell Co., W. E.
Delany & Co., P.
Erie City Iron Works
Green Engineering Co.
Heine Boiler Co.
Lebanon Boiler Works
Newburgh Steam Boiler Wks.
Smith & Sons, Samuel
Union Iron Works

Tape
General Electric Co.

Thermometers
Bristol Co.
Hays Corp., Jos. W.
Sarco Co.
Taylor Instrument Co's.

Thermometers, Flue Gas
Bailey Meter Co.

Thermometers, Recording
Bailey Meter Co.
Foxboro Co.
Sarco Co.
Taylor Instrument Co's.

Transformers
Allis-Chalmers Mfg. Co.
General Electric Co.
Westinghouse E. & M. Co.

Transmission Machinery (See Power Transmission Machinery)

Traps, Compressed Air
Armstrong Machine Works
Nicholson & Co., W. H.

Traps, Grease
Armstrong Machine Works

Traps, Non-Return
Armstrong Machine Works
Bundy Steam Trap Co.

Traps, Radiator
Armstrong Machine Works
Sarco Company

Traps, Return
Bundy Steam Trap Co.
Morehead Mfg. Co.
Strong, Carlisle & Hammond Co., The
Templeton Mfg. Co.

Traps, Steam
American District Steam Co.
Armstrong Mach. Works
Bundy Steam Trap Co.
Crane Co.
Elliott Co.
d'Estes Co., Julian
H. S. B. W. Cochrane Corp.
Jenkins Bros.
Johns-Manville, Inc.
Morehead Mfg. Co.
Reliance Gauge Column Co.
Sarco Co.
Schutte & Koerting Co.
Squires Co., C. E.
Strong, Carlisle & Hammond Co.
Watson & McDaniel Co.
Webster & Co., Warren
Wright-Austin Co.

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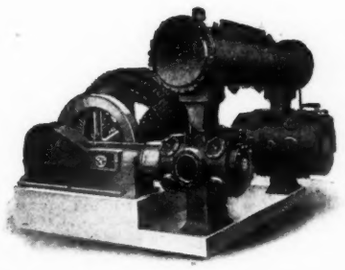
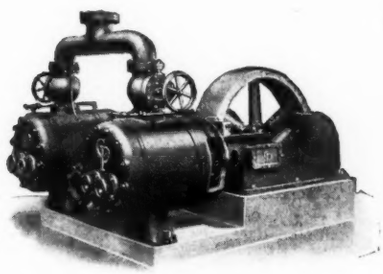
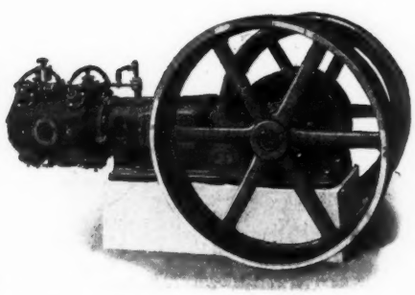


C-P Class O-CE Two Stage Direct Connected Motor Driven Air Compressor.



C-P Dry Vacuum Pump. Built in single and duplex types. Steam, belt and motor driven. Capacities 122 to 9000 cu. ft. per minute. Ask for Bulletin 710.



C-P Class N-SB Single Stage Belt Driven Air Compressor.

C-P Air Compressors are built in 500 sizes and types, all modern. Capacities up to 10,000 cu. ft. per minute.

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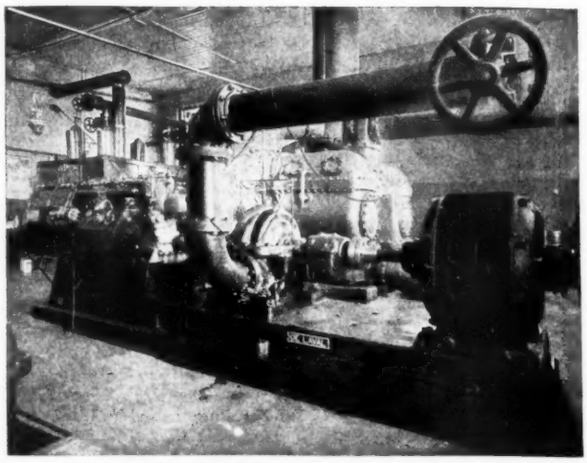

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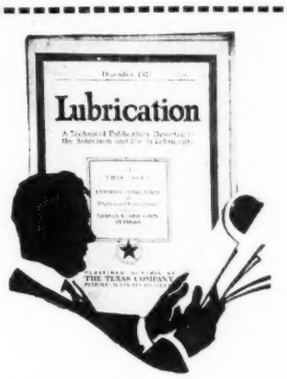

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